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AUTHOR
Coats, William D.

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ABSTRACT An investigation and simulation of the relationships among classroom verbal interaction variables, student attitudes, and achievements constitute the focal points of this study. The investigation aspect of the study uses statistical procedures to identify classroom variables significantly associated with educational outcomes and to determine the nature of the associations through trend, strength, and regression analysis. The simulation is achieved by using the digital computer to make operative an educational model based on the information obtained by the statistical investigation. By analyzing empirical data on thirty selected independent classroom variables and the dependen variables of student achievement and attitude this project had the following specific objectives: (1) the isolation of those independent variables which have significant associations with the dependent variables of class achievement and/or attitude; (2) the calculation of the strength of association between independent and dependent variables; (3) the determination of the trend of association for all independent-dependent variable relationships; (4) the construction of regression equations representing the relative contributions of important indepen ent variables in predicting class achievement and attitude; and (5) the development of an operative computer model to simulate some aspects of an educational process. The general significance of this study relates to the improvement of educational instruction. (JL)

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INVESTIGATION AND SIMULATION OF THE RELATIONSHIPS AMONG SELECTED CLASSROOM VARIABLES

Cooperative Research Project No. 6-8330

William D. Coats

The University of Michigan
Ann Arbor, Michigan

1966

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CHAPTER I

INTRODUCTION

Statement of the Problem

An investigation and simulation of the relationships among classroom verbal interaction variables, student attitudes, and achievements constitute the focal points of this study. The investigation aspect of the study uses statistical procedures to identify classroom variables significantly associated with educational outcomes and to determine the nature of the associations through trend, strength, and regression analysis. The simulation is achieved by using the digital computer to make operative an educational model based on the information obtained by the statistical investigation.

The variables investigated consist of thirty classroom predictor variables and two outcome variables. The thirty independent[1] or predictor variables can be partitioned into three uncontrollable and twenty-seven controllable variables. The uncontrollable variables are achievement, attitude, and I. Q. of a class prior to a given learning situation. The controllable variables are measures of various types of verbal communication which occur during classroom learning activities. Basically, the verbal interaction variables relate to the expansion or restriction of student freedom. Examples of these variables are: teacher acceptance of student ideas, student initiated responses, praise of students, and teacher questions. The outcome or dependent variables are the attitudes and academic achievements of classrooms at the end of sustained teaching-learning experiences. A complete theoretical and operational description of all variables is presented in Chapter III.

---

[1] The fact that predictor variables are often referred to as independent variables in this study does not mean that the predictor variables are independent of each other.

Data of this study consist of class means rather than individual student scores. The necessity of using class means and some resulting problems of interpretation are also discussed in Chapter III.

Objectives

Although this research effort has been profoundly influenced by a number of different theories of instruction, it should not be thought of as trying to support or discredit any particular theory. Rather, the study described herein was an attempt to learn something about the nature of associations between and among a large number of classroom variables. Hopefully, the results of hypothesis testing, question answering, and model developing which follow will contribute some useful information to educators in general and to instruction theorists in particular.

By analyzing empirical data on thirty selected independent classroom variables and the dependent variables of student achievement and attitude this project had the following specific objectives:

1. the isolation of those independent variables which have significant associations with the dependent variables of class achievement and/or attitude;

2. the calculation of the strength of association between independent and dependent variables;

3. the determination of the trend of association for all independent-dependent variable relationships;

4. the construction of regression equations representing the relative contributions of important independent variables in predicting class achievement and attitude;

5. the development of an operative computer model to simulate some aspects of an educational process.

Educational Significance

The general significance of this study relates to the improvement of educational instruction. However, the study is exploratory in many respects and has more immediate relevance to the educational researcher than the classroom teacher. It is hoped that the information presented in what follows will facilitate further research more directly applicable to classroom instruction. A treatment of the educational significance of each of the five objectives proposed in the preceding section constitutes the remainder of this section.

Much of the energy devoted to the fulfillment of educational objectives could be more useful if it concerned variables which are in fact related to educational outcomes. The first objective is an attempt to ascertain which associations might merit further investigation. Is the degree to which a teacher uses praise, encouragement, or criticism really related to the achievement level of children? There is a need for researchers, through the use of appropriate methods of statistical analysis, to isolate variables of all types which do or do not have higher than chance associations with important dependent classroom variables.

In educational research a significant result generally enables one to infer that some association exists between an independent variable (X) and a dependent variable (Y). However, knowledge only that an association exists is incomplete. Any two variables are "associated" in some degree, and this association, no matter how trivial, will be statistically detected if the experimenter has a large enough sample.

The second objective is designed to provide information about the strength of associations. Strength analysis can add much to the conventional test of significance because it indicates the extent to which knowledge about X tends to reduce uncertainty about Y. This relative reduction in uncertainty is more commonly referred to as the proportion of variance in Y which is accounted for by X.

The third objective adds another informational dimension to knowledge obtained from investigations of significance and strength of associations. Trend analysis is an important consideration because it indicates the type (s) of regression represented in the associations investigated. Is the independent-dependent variable relationship essentially linear, curvillinear, etc. ? It is possible that achievement increases exponentially rather than linearly as I. Q. increases. And student attitudes might improve and than begin wane as the teacher becomes increasingly accepting of student ideas.

The kinds of analyses discussed above are for single independent-dependent variable relationships. And, at least initially, the researcher should be concerned with these pair-wise associations and the resulting predictive capabilities.

However, there is also a need to consider the interactive contributions which various combinations of classroom variables make toward the prediction of outcome variables. Although several different variables may be related to the learning of children, they might not offer any better prediction of learning collectively than individually. The fourth objective makes use of a statistical technique which considers the relative contributions of independent variables in predicting values of dependent variables. The technique is called multiple linear regression analysis.

The interactions in a particular teaching-learning process are probably too complex to ever be reliably represented by a few Newtonian-type principles. Fattu suggests (1965, p. 4) that

> -future development in educational research more probably lies in finding new ways to use large numbers of fairly trivial propositions, none of which alone accounts for much of the observed variance, but all of which operating together cause the observable real differences that are so difficult to study by conventional statistical procedures.

The fifth objective involves a research method which appears to be a first step toward Fattu's ideal for fruitfully investigating complex educational processes. The method referred to is computer simulation. In this paper a computer simulation is thought of as the kind of operational model described byDawson (1962, p. 3). Dawson says that, "Simulation, as a social science research technique, refers to the construction and manipulation of an operating model, that model being a physical or symbolic representation of all or some aspects of a social or psychological process."

As was true in general data processing applications, people with major interests in areas other than education have been doing the pioneering work in computer simulation of educational processes. Simulation could more effectively improve understanding of educational problems if educators became involved in the development of the simulation. Properly undertaken, computer simulation should be able to generate descriptive models which increase the precision and understanding of more general models and theories.

Availability of Data

The opportunity to fulfill the objectives of this dissertation became available as a result of several studies by Flanders (1965) on classroom interaction analysis. Over the past ten years Flanders directed research teams have collected a large amount of empirical data on many teacher-learner variables. These studies emphasized variables related to classroom verbal interactions and were based upon three different grade levels consisting of 29 sixth, 15 seventh, and 16 eighth grade classes.

Because of the power of the research tool used (matrix tabulation), the data relate to many more variables than were investigated by or of interest to the original data gatherers. As indicated in Appendix A, a

10 by 10 matrix provides measurements on literally hundreds (all combinations of 100 things taken at a time) of classroom variables. Of course, many of these variables can be eliminated through intuitive and logical considerations as having no theoretical or predictive significance. But some appear to have potentially important associations with meaningful educational outcomes. There is a critical need for a researcher to use this mass of interrelated data to ascertain which variables operationalized by the matrix are related to student achievements and attitudes and to learn something about the nature of such relationships.

The research setting described above offered several utilitarian advantages over a new data collection. One advantage was the fact that the available data were far more comprehensive and representative than any which the writer (with limited time and money) would have been able to collect. Also, information about what the interaction data in particular have to say regarding many heretofore univestigated relationships is needed. Finally, further analysis of the existing data should increase the precision of the general model for which the data were originally gathered. Although existing data were used, this study is a completely independent research effort with respect to conceptualization, design, and data analysis.

Overview

Chapter I has included a statement of the problem, a listing of specific objectives, a discussion of the educational significance, and a description of the research setting of this study.

Chapter II contains a review of literature directly related to interaction analysis and to relevant factors associated with student achievement and attitude. The chapter concludes with a discussion of some predictive models and a chapter summary.

Chapter III presents the hypotheses to be tested and questions to be answered, a description of the sample, the names and definitions of variables investigated, procedures to be followed, and some limitations of the research design.

Chapter IV relates the results of statistical analyses and model development to the proposed objectives and discusses important findings and interpretations.

Chapter V summarizes the study and discusses immediate implications for further research.

CHAPTER II

RELATED LITERATURE AND IMPLICATIONS FOR PRESENT STUDY

The review of related literature involves research in three major areas. One area concerns the development of interaction analysis as a research tool and the specific projects for which the data used in this study were originally gathered. Another relates to what other researchers have found out about relevant independent-dependent variable associations. And the third area consists of some predictive studies.

Brief justifications for reviewing these three areas of the literature follow. The emphasis on the development of interaction analysis is an attempt to provide the reader with much of the rationale which governed the collection of the data used here. The second research area mentioned above is pertinent to the objectives of determining the nature of selected independent-dependent variable relationships. Finally, a review of some predictive studies should provide information related to both the regression analysis and computer model aspects of the dissertation.

This chapter considers only those researches which the writer believed to be both representative of the literature and central to the theoretical development of this paper.

Interaction Analysis

This section discusses the historical and theoretical development of Flanders' system of interaction analysis. Consideration is also given to the objectives and results of antecedent research efforts which produced the raw data used in this study.

Historical and Theoretical Development

Two major approaches to the collection and interpretation of interaction analysis data are in use today. One emphasizes the logical and cognitive levels of verbal communication in the classroom. The reader can learn more about this approach by looking at the writings of Smith et. al (1962), Wright and Proctor (1961), Bellack and Davitz (1963), and Aschner (1963). The second approach concentrates more on those types of verbal interactions which are related to what is known about classroom climate. Flanders (1965, p. 3) refers to the term "classroom climate" as "generalized attitudes toward the teacher and the class that the pupils share in common despite individual differences."

Early studies on the affective climate of groups, which is closely akin to classroom climate, have provided much of the theoretical foundation upon which interaction analysis rests today. Some of the most important research in this area has come from the work of Anderson (1939), Anderson and Brewer (1945), Lippitt and White (1943), Rehage (1954), Deutsch (1949), Withall (1949), Perkins (1951), Flanders (1951), Rogers (1946), and Cogan (1956). Although these studies produced fairly consistent results, they usually used quite different words to describe concepts which represented essentially the same variables. For example, some of the terms which various of the above researchers have used to refer to contrasting leader behaviors are: dominative vs. integrative, authoritarian vs. democratic vs. laissez faire, pupil-teacher planning vs. teacher-directed procedures, cooperation vs. competition, teacher-centered vs. pupil-centered, and preclusive vs. inclusive.

In an attempt to coordinate and integrate relevant research on the teacher as a classroom leader Cronbach (1954) has coined the terms "undirected activities", "teacher-controlled activities", and "group-controlled activities" to represent the contrasting types of classroom control patterns. Using his own terms, Cronbach summarizes the reserch results of the studies listed in the preceding paragraph in Table 1.

While building upon the research results mentioned in Table 2, Flanders (1965) attempted to increase the objectivity of classroom climate terminology by using the words "direct" and "indirect" to describe contrasting types of teacher influence. He defines an indirect teacher influence as occurring when a teacher accepts student feeling, praises students, accepts student ideas, or asks questions of students. Direct teacher influence is said to take place when the teacher is lecturing, giving directions, criticizing students, or justifying his own authority. The specific categories developed by Flanders are defined in Table 2 on page 13.

Basically, the distinction between direct and indirect teacher influence is determined by the extent to which student freedom of action is expanded or restricted. Believing that a teacher may want to be both indirect and direct, depending upon the nature of the teaching-learning

TABLE I

Effect of three control patterns: a summary[a]

Outcome	Effect of Undirected Activities	Effect of Teacher Controlled Activities	Effect of Group Controlled Activities
Emotional security	Disturbing because of low accomplishments	Relieves anxiety by setting definite standards, provided goals are stated.	Frustrating if group feels planning wastes time.
Enjoyment	Enjoyable until anxiety appears.	Enjoyment depends on the work; little social satisfaction.	Enjoyable if group feels it is progressing. Promotes friendly interaction.
Effort and efficiency	Frequently wasteful of energy. Low persistence.	Effective if group accepts direction and if leadership is maintained. Group may resist direction and make minimum effort.	Leads to greater acceptance of goals, and continued effort when leader is absent. Leads to understanding of task and self-direction.
Learning of course material	No direct evidence. Probably ineffective compared to other approaches.	As good as group control.	As good as teacher control. Encourages free expression of ideas and feelings. Possibly superior for altering attitudes.
Learning skills of group membership	No better than spontaneous play.	Little opportunity for social learning.	Provides directed training in planning, teamwork and leadership.

---

[a] From Cronbach, 1954, p. 459.

TABLE 2

CATEGORIES OF INTERACTION ANALYSIS[a]

TEACHER TALK	Response	1.[b] ACCEPTS FEELING: accepts and clarifies the feeling tone of the students in a non-threatening manner. Feelings may be positive or negative. Predicting or recalling feelings are included.
		2.[b] PRAISES OR ENCOURAGES: praises or encourages student action or behavior. Jokes that release tension, but not at the expense of another individual, nodding head, or saying "um hum," or "go on" are included.
		3.[b] ACCEPTS OR USES IDEAS OF STUDENTS: clarifying, building, or developing ideas suggested by a student. As teacher brings more of his own ideas into play, shift to category five.
		4.[b] ASKS QUESTIONS: asking a question about content or procedure with the intent that a student answer.
	Initiation	5.[b] LECTURING: giving facts or opinions about content or procedures; expressing his own ideas, asking rhetorical questions.
		6.[b] GIVING DIRECTIONS: directions, commands or orders to which a student is expected to comply.
		7.[b] CRITICIZING OR JUSTIFYING AUTHORITY: statements intended to change student behavior from non-acceptable to acceptable pattern; bawling someone out; stating why the teacher is doing what he is doing, extreme self-reference.
STUDENT TALK	Response	8.[b] STUDENT TALK-RESPONSE: talk by students in response to teacher. Teacher initiates the contact or solicits student statement.
	Initiation	9.[b] STUDENT TALK-INITIATION: talk by students which they initiate. If "calling on" student is only to indicate who may talk next, observer must decide whether student wanted to talk. If he did, use this category.
		10.[b] SILENCE OR CONFUSION: pauses, short periods of silence and periods of confusion in which communication cannot be understood by the observer.

[a] From Flanders, 1965, p. 20.

[b] There is NO scale implied by these numbers. Each number is classificatory; it designates a particular kind of communication event. To write these numbers down during observation is to enumerate, not to judge a position on a scale.

situation, Flanders has also introduced the term "flexibility" to refer to a desirable variance in student freedom of action.

The method of operationalizing indirect and direct teacher influence owes much to the work on interaction process analysis done by Bales (1951, chapt. 2). Although Bales' work focused about face-to-face interactions in small adult groups rather than the public school classroom, his positive vs. negative social-emotional area and asking for vs. giving of suggestion, opinion, and orientation are quite similar to indirect vs. direct teacher influence.

The specific categories illustrated in Table 2 and the 10 by 10 matrix discussed in Appendix A are the instruments used to quantify teacher influence. A teacher's position on the direct-indirect continuum is determined by calculating the ratio of the number of tallies in columns 1-3 to the number of tallies in columns 6 and 7. This ratio (i/d) is a measure of the ratio of indirect teacher influence to direct teacher influence during a given observation period. A measure of teacher flexibility to adapt to different classroom situations has been obtained by calculating the range of i/d ratios across the different time use categories mentioned in Appendix A.

Research Objectives and Results

As indicated earlier, the data used for this study were collected by interrelated research teams in Minnesota between 1958 and 1960 and in Michigan from 1963 to 1965. Perhaps some mention of the objectives and results of these research efforts will increase the reader's understanding of the type of data considered here.

The rationale for the Minnesota data emphasized two major outcomes. One emphasis was the development and refinement of a research tool which used interaction analysis to quantify the quality of the spontaneous verbal communication between teacher and pupils in a classroom situation. The other major emphasis of rationale involved the testing of hypotheses which related teacher influence to the outcome variables of student achievement and attitude.

The Minnesota data have thus far related to two major and relevant studies. Using the first year data on 140 dependent-prone eighth grade students, Amidon and Flanders (1961) found: (1) students with indirect teachers learned more than students with direct teachers; and (2) dependent-prone students had better achievement under indirect teacher influence than under direct teacher influence. In the following year, Flanders considered a sample of 15 seventh grade social studies classes and 16 eighth grade mathematics classes and was unable to support the contention that dependent-prone students learned more from indirect teachers than from direct ones. However, he did find: (1) students who had indirect teachers both learned more material and had better attitudes toward the teacher and school than did the students who had direct teachers; and (2) indirect teachers became more direct as the learning goals became more clear. The association between pupil attitudes and teacher influence supported earlier research by Flanders (1965) in New Zealand.

The Michigan data on sixth graders comes from the first year of a 55 month study involving sixth, fourth, and second grade classes. The objectives of the Michigan studies are:

> (1) to establish normative data for teacher influence patterns at the three grade levels of the elementary classroom by applying the technique of interaction analysis and tabulating the data separately for different teaching situations; (2) given a group of classes in which the attitudes and content achievement of the pupils are above average, compared with another group of classes in which these measures are below average, we hypothesize that in the above average classrooms--a) more indirect teacher influence will occur when new material is being introduced and when the diagnosis of difficulties occurs, b) more direct teacher influence will occur at the later stages of classroom learning cycles, c) more flexible patterns of teacher behavior will occur across different teaching situations and d) more indirect influence will occur during all phases of teaching; (3) to develop a prototype apparatus for tabulating interaction analysis data directly into matrices; and (4) to select a small non-representative sample of teachers whose natural style of teaching is more flexible and whose pupils score above average on measures of constructive attitudes and content achievement--to expose these teachers to specialized training in an effort to have them demonstrate patterns of interaction which will help us to develop models of teacher influence for different teaching situations which occur at these grade levels. (Flanders, 1963).

As of now, the sixth grade data in Michigan have been used in just one other study. Morrison (1966) classified some students as internal and others as external by isolating "students who believed that they controlled their behavior from those who believed their behavior was controlled by external forces." The study by Morrison indicated that "internal children learned more than did external children in the areas of language, study skills, and arithmetic skills." Also, her study reaffirmed the above findings of Flanders regarding teacher influence and student achievement.

In summary, the theory underlying the collection of the data considered here gave more emphasis to the social skills involved in classroom management than to the logical and cognitive aspects of classroom behavior.

There is evidence of an association between a teacher's social skills and student attitudes and achievements.

Research on Relevant Independent-Dependent Variable Associations

What other researchers have found out about associations between relevant classroom variables and student achievements and attitudes represents useful information for the selection of variables to be investigated here and gives some indication of the reasonableness or consistency of the findings of this study compared with other studies. Can student attitudes or achievements be appreciably altered by variations in teacher influence or are they essentially predetermined and constant across different teaching patterns?

Relation of Selected Variables to Achievement and Attitude

There are two major categories of classroom variables. Those falling in one group are factors over which we have little control, either as teacher or pupil, when facing a new learning task. Examples of these uncontrollable factors are: I. Q., organismic age (Olson, 1959), pre-achievement, pre-attitude, home environment, etc. The other group consists of factors which are somewhat controllable in a given learning situation. Classroom climate and verbal interaction variables are salient examples of at least partially controllable variables.

If one starts comparing the relative importance of uncontrollable factors and controllable factors, one soon becomes involved in the old nature-nurture issue. Hebb (1958) says that both heredity and environment are of 100% importance and to ask the relative contributions of either is like asking how much the length and width of a rectange contribute to its area. However, in a mathematical sense, one may very well want to know how much the length and width of a rectangle contribute to its area. If the length is held constant, how much must the width be increased to increase the area to some desired figure? In a like manner, if student capacity to learn is held constant for a given learning experience, what can be done (if anything) to teacher influence to significantly increase learning?

The literature of educational research is replete with seemingly contradictory results. Some studies indicate that teaching methodology is an important factor in determining student attitudes and academic achievements while other studies suggest opposite implications. Stern (1963) has summarized the results of 34 studies which are extremely relevant to this research project in Table 3. The studies reviewed by Stern were "designed explicitly to measure the differences between student-and teacher-centered instruction in their effect on either the acquisition of information, changes in attitude, or both."

The studies represented in Table 3 and in Table 1 of the preceding section suggest that variables related to a teacher's verbal behavior have more and stronger associations with student attitudes than with academic achievements. Therefore, the verbal interaction variables to be defined in the next chapter are likely to have some important relationships with student attitudes. However, most of the studies lend little support for the existence of a consistent cause and effect relationship between academic

TABLE 3

Relative Advantages of Nondirective over Directive Instruction in Influencing Two Types of Learning Outcome[d]

Attitude Change (Self or Others)	Gain in Achievement of Cognitive Knowledge and Understanding		
	Negative	No Difference or Unmeasured	Positive
Positive	Asch (1951)[a]	Anderson & Brewer (1946) Anderson, Brewer, & Reed (1946) Anderson & Kell (1954) Bills (1952)[a] Bills (1956)[a] Bovard (1951a, 1951b) Bovard (1952) DeLong (1949)[b] Di Vesta (1954) Flanders (1951)[a] Gross (1948) Lewin, Lippit, & White (1939)[a] Patton (1955)[a] Wieder (1954)[b]	No cases reported
No difference or unmeasured	Brookover (1943, 1945)[c] Burke (1955) Calvin, Hoffman & Harden (1957) Guetzkow, Kelly & McKeachie (1954)[b]	Deignan (1955)[a] Eglash (1957) Fersh (1949) Johnson & Smith (1953)[c] Krumboltz & Farquhar (1957) Lagey (1956) Landsman (1950)[c] McKeachie (1954a, [b]1954b) Slomowitz (1955)[a] Ward (1956) R.P. Watson (1956)[c] Wispe (1951)[c]	Faw (1949)[c] Thompson & Tom (1957)
Negative	No cases reported	No cases reported	No cases reported

a) expressed student satisfaction with student-centered class

b) expressed student dissatisfaction with student-centered class.

c) mixed student reaction to student-centered class.

d) From Stern, 1963 p. 427.

achievement of students and the directness or indirectness of teacher talk.

A recent and very comprehensive Cooperative Research Project completed by Ketcham and Morse (1965) has produced results which are in conformance with the general thrust of Tables 1 and 3. The original sample consisted of third, fourth, fifth, seventh, and ninth grade pupils at the University School, Ann Arbor, Michigan. Data were gathered over a three year period in an effort to provide longitudinal comparisons for the same group at different age-grade levels and cross-sectional comparisons for different groups at the same age-grade level. The data consisted of indices of learning, social structure, social climate, and mental health. The authors' conclusions were:

1. The existence of a strong relationship between social and psychological development and school achievement within classroom groups is not supported by the findings of this study.
2. School achievement is predominately a function of children's growth and maturation which appear to be valid and reliable predictors of within and between group differences.
3. Social and psychological development and growth and maturation are best viewed as two distinct global human achievement factors, the former having a dominant environmental orientation and the latter having a dominant organismic orientation.
4. There is nothing inherent in the human organism which necessarily dictates that children less favorably endowed organismically need to suffer a debilitating personal-social development

because of their below average school achievement.

5. As children progress through the elementary and secondary schools their self image and self esteem take on an increasingly negative quality..

6. A worthy educational objective could be one of permitting, better yet promoting, a rise in the level and reduction in the variability of personal-social achievement in the presence of the predictable level and wide variability of school achievement which prevails in all classroom groups.

7. Assisting children with their personal-social achievement in the classroom is a worthy purpose but it must stand on its own merits and cannot be viewed as an effective means of raising the level or reducing the variability of school achievement.

8. Children who enjoy a healthy personal-social development may be easier to teach but they will not necessarily either learn more easily or learn larger quantities of what the schools teach.

The above conclusions which are of particular relevance to the research of this writer imply that:

1. Uncontrollable factors have a much stronger association with student academic achievement than do controllable ones;

2. controllable factors have a stronger association with student attitude (personal-social achievement) than do uncontrollable factors;

3. student attitudes can be fairly independent of academic achievement.

Relation between Achievement and Attitude

The fact that a child's attitudes toward his school and teacher are probably more amenable to change than his capacity to learn academic material is not surprising. But the possibility of no association between pupils' attitudes and achievements is intriguing. Some studies suggest that student attitudes may be related to teacher evaluated achievement but unrelated to standardized tests of achievement.

Malpass (1953) hypothesized that there would be a relationship between students' perceptions of school and their academic achievement for 92 eighth graders who had had the same teacher for at least two years. His hypothesis was supported with respect to end of semester grades but rejected with respect to standardized tests. He conjectured that negative student attitudes might result in low teacher evaluation or vice versa. The weight of evidence in the Malpass study suggests that there is little relationship between how children view the school situation and objectively measured knowledge.

Matlin and Mendelsohn (1956) found significant correlations $(r = .30 - .32)$ between a student's personal-social adjustment and the teacher's perception of the child's achievement but found no significant correlations $(r = .09 - .4)$ when standardized tests were used to evaluate achievement.

Jackson and Getzels (1959) considered students from a private school who were 1 1/2 standard deviations above or below the mean on the

Student Opinion Poll which is supposed to measure degree of student satisfaction with school. Satisfied and dissatisfied students did not differ in either general intellectual ability or scholastic achievement.

While attempting to cross validate an attitude scale for the identification of high and low achievers, Austrin (1966) obtained a correlation of .55 between student attitudes and scholastic average.

Brodie (1964) selected eleventh graders from a midwest high school in the same way as did Jackson and Getzels above. After using nine subtests of the Iowa Test of Educational Development (ITED) to measure achievement, he concluded that negative attitude toward school would appear to have an inhibitory effect on learning of classroom material but would not be influential on learning of a more general nature.

Because measures on both achievement and attitude were obtained for use in this study by standardized paper and pencil tests, the above research indicates that those classroom variables considered in what follows, which are associated with achievement, are not necessarily the same as those associated with student attitudes and vice versa.

The research reviewed in this section also offered many positive suggestions to the author regarding which verbal interaction variables to select for investigation. It appears that those variables which concern student-centered activities and student freedom to participate, manage, and act are likely to be related to student attitudes. Also, a few of the studies found associations between teacher influence variables and student achievement. However, the associations with achievement were not always consistent.

Relation of Learning Theory to Data

The writings of Hilgard and Hough probably provided more influential guidance than the above studies in helping the writer determine which verbal interaction variables might be related to achievement.

After reviewing the literature on learning theory, Hilgard (1956) made a list of fourteen learning principles on which he believed learning theorists of all types could find considerable agreement. The data used in this study empirically relate some of these principles to learning outcomes.

The most relevant of Hildgard's principles are:

1. There are large individual differences in capacity.
2. Intrinsic motivation promotes more effective learning than does extrinsic motivation.
3. Reward makes for more effective learning than does punishment.
4. Failure during learning is best tolerated when there is a backlog of success.
5. Individuals need practice in setting realistic goals.
6. Active participation in learning is more effective than passive reception.
7. Feedback of the results of one's performance is important.
8. Transfer of learning is most effective when the learner can discover relationships for himself and apply the principles in a variety of tasks.

Hough (1964) engaged in a fairly comprehensive discussion of the relationships between reinforcement learning theory and classroom verbal interaction variables. He concluded his paper by hypothesizing ten principles of instruction which he felt to be both consistent with a reinforcement theory of learning and translatable into teacher and student behavior. Six of his ten principles which are directly related to the data available here are:

1. During the course of the unit, criticism, sarcasm and justification of authority should be avoided since such behavior represents aversive stimulation and as such could interfere with verbal learning.

2. During the course of the unit, the teacher should maintain an optimum amount of overt student behavior by asking questions, encouraging students, accepting student responses and responding to student questions.

3. Teachers should avoid using praise and corrective feedback following emitted student responses unless such responses are clearly correct or incorrect by definition, custom or empirical validation.

4. Teachers should make a conscious effort to develop a classroom climate where students feel free to ask questions of clarification and state opinions in order to further their understanding. In order to establish this type of climate, teachers should emphasize the use of encouragement and acceptance and clarification of feeling and acceptance of ideas and should avoid the use of criticism and sarcasm.

5. Incorrect responses should not go uncorrected but should receive corrective feedback or should be thrown back to the student for clarification and correction. To allow incorrect response to go unnoticed runs the risk or self reinforcement of incorrect responses with students who have an incomplete or faulty structure of understanding.

6. Reinforcement is only possible following a response, this being the case every attempt should be made to stimulate active involvement (both overt and covert) and to stimulate overt verbal involvement for purposes of reinforcement and corrective feedback.

Studies Using Predictive Models

The main reason for including predictive studies in a review of the literature was to give the writer and the reader an idea of how some of the results to be reported in Chapter IV compare with the results of other studies using multiple linear regression analysis. Predictive studies are particularly relevant to both the regression equations and computer model discussed under the fourth and fifth objectives of Chapter I because multiple linear regression analysis (1) is almost universally used in predictive studies, (2) was the statistical procedure used to construct the regression equations, and (3) provided the foundation for the computer model.

Intellective Factors

A review of studies on human development by Bloom (1963) suggests that future achievement can best be predicted by previous achievement of the same type. Bloom stated, "Highly reliable achievement test batteries administered to students during high school and then again at the end of one or two years of college reveal correlations of approximately .92 which is very close to the theoretical value [Bloom estimates a theoretical correlation between achievement indices earlier in the article to be about .95] derived from absolute scales."

Courtis (1925) studied the interrelationships among some factors conditioning the school progress of children in grades three to eight. The equation reported predicted standardized achievement scores on the Stanford Test and DetroitArmy Intelligence Test, age in months, and number of semesters at school. With these nearly ancient predictor variables the equation yielded a multiple correlation coefficient of .91 and accounted for 83% of the variance in the standardized achievement scores.

Guilford, Hoepfner, and Peterson (1965) added 13 structure-of-intellect ability subscales to conventional aptitude tests on the assumption that adding tests of new factors to existing predictors would increase the predictive value of test batteries. The conventional tests were the California Test of Mental Maturity (CTMM), the Iowa Every Pupil Test (IEPT), and the Differential Aptitude Test (DAT). The measures to be predicted were achievement in ninth grade basic mathematics, non-college Algebra, regular Algebra, and accelerated Algebra. Where the usual aptitude tests were individually used to predict achievement the multiple correlation coefficients ranged from .24 to .72. The multiple correlation coefficients resulting from the addition of the 13 structure-of-intellect scales to the separate standard batteries varied from .54 to .85. These increases were significant in some cases.

Non-Intellective Factors

A study giving some support to psychological variables as predictors of achievement was done by Gough (1964). In a cross-cultural study he developed equations for predicting grade averages of 341 students in four different Italian schools. The measures he used were the 18 sub-scales of the California Psychological Inventory (CPI) and the D48 nonverbal test of general intelligence. He obtained predictive equations for males and females separately, but concluded that it "makes little difference which equation is used" since the correlation between male and female scores was .97. The multiple linear regression equation which yielded the best prediction of student grades consisted only of three sub-scales of the CPI. These subscales were measures of: (1) achievement via conformance (Ac) which dealt with self-discipline, accepting of rules, and convergent thinking; (2) achievement via independence (Ai) which concerned independence, creative method, and divergent thinking; and (3) flexibility (Fx). Although the D48 nonverbal ability test was not an important predictor of student grades, Gough noted, "it might well be that a verbal test of ability would have fared better as a predictor of scholastic performance." The best predictive equations had a multiple correlation coefficient of .45. So, the CPI sub-scales of Ac, Ai, and Fx accounted for about 20% of the variance in student grade averages.

Finger and Schlesser (1965) lend further support to the idea that non-intellective variables can have at least some value as predictors of academic achievement. By using the technique of factor analysis on college Personal Values Inventory (PVI) scores, they showed that certain scales of the PVI are heavily loaded on some factors of academic success.

Intellective Plus Non-Intellective Factors

Some of the research reviewed in this chapter suggests that many non-intellective variables are often intercorrelated with intellective variables. Therefore, when only non-intellective variables are used to predict achievement it is often difficult to decide what portion of the obtained predictive power is independent of that offered by intellective variables. Many researchers have solved this problem by ascertaining the extent to which measures on both non-intellective and intellective variables increase the multiple correlation coefficient yielded by intellective variables alone.

McCandless and Castaneda (1956) studied the relationships between anxiety, school achievement, and intelligence in fourth, fifth, and sixth grade school children. Anxiety was measured by a children's form of the manifest anxiety scale (CMAS), academic achievement by the Iowa Every Pupil Test (IEPT), and intelligence by the Otis Quick Score, form B. Multiple linear regression equations using both CMAS and Otis scores to predict IEPT scores accounted for less than a 2.5% increase in the proportion of variance accounted for over the Otis scores alone.

After reviewing several predictive studies, Mayhew (1965) concluded that multiple correlation coefficients of equations using high school rank and scholastic aptitude to predict college freshman grade point averages generally ranged from .37 to .83 with a median of about .62. Also, whenever studies used more than these two intellective indices to predict college grades, gains in the multiple correlation coefficients were so slight as to be negligible.

Fishman and Pasanella (1960) reviewed over 200 studies which used correlation and regression analysis in their research design. They found that most of the studies used either intellective predictors (aptitude, achievement, grades) or non-intellective predictors (personality, motivation, attitudes) or both to predict some kind of academic attainment. Two-hundred-sixteen multiple correlation studies using only intellective factors to predict various types of academic success obtained multiple correlation coefficients ranging from .31 to .83 with a median of about .63. In general, the addition of non-intellective factors to intellective factors in multiple linear regression equations for predicting achievement resulted in an increase in the multiple correlation coefficient of only .04 to .09.

Meyers and Schultz (1950) reported the results of research related to improvement of the predictive capabilities of the College Entrance Examination Board. In that research a questionnaire was developed to tap the attitudes, interests, and motivation of potential college students. When added to a battery of Scholastic Aptitude Test (SAT) scores, the newly developed attitude-interest questionnaire increased the multiple correlation coefficient by no more than .01.

Edminston and Rhoades (1959) used regression analysis to predict school marks and general achievement for 94 high school seniors. Table 4 indicates the variables considered, and Table 5 contains some of the multiple correlation co-efficients.

Table 4

Variable Number and Definition

Variable	Definition
1.	average school marks for 3 and 1/2 years

Table 4 Continued

Variable	Definition
2.	general achievement scores from California Achievement Test
3.	language intelligence scores from California Test of Mental Maturity
4.	Edminston how-to-study test scores
5.	school adjustment scores from California Test of Personality
6.	sociometric - scores from acceptance and rejection using four questions
7.	attention observed during study and test periods
8.	total adjustment scores from average of California Test of Personality and Bell's Adjustment Inventory
9.	achievement ratio scores from the ratio of California Achievement Test T-scores to California Test of Mental Maturity T-scores

Table 5

Multiple Correlations

$R_{1.3} = .56$	$R_{2.9} = .87$
$R_{1.34} = .63$	$R_{2.93} = .98$
$R_{1.346} = .73$	$R_{2.937} = .98$
$R_{1.3467} = .75$	$R_{2.934} = .98$
$R_{1.34679} = .83$	$R_{2.9347} = .98$

In agreement with some of the research reported in the preceding section, Table 5 indicates that school marks are more influenced by socio-psychological factors than are scores on general achievement tests. Note that just two ability variables accounted for almost all of variance (96%) in general achievement.

The high ratio of predictor variables to observations (1:10) in the Edminston and Rhoades study led to a biased estimate of the multiple correlation coefficients in the positive direction (McNemar, 1962, pp. 184-185). The same problem plagued the analyses to be reported in Chapter 4 of this dissertation. McNemar's method of handling the problem will be discussed in the following chapter on research design.

The studies considered in this section provided strong and consistent support for the contention that previous achievement and other intellective factors are by far the best predictors of future achievement. However, there was also some support for the statement that measures on socio-psychological variables can increase the power of intellective variables in predicting academic achievement.

It can be argued that since intellective predictor tests in the above studies asked for the same type of responses as did the predicted achievement tests, the multiple correlation coefficients can be expected to be artificially high. Nevertheless, the intellective measures were good predictors of various kinds of academic achievement. Perhaps the root of the problem lies in the method of operationalizing achievement. Most educators would probably like to attribute a much broader meaning to achievement than that which is actually quantified by conventional achievement tests.

Summary of Related Literature

The theory underlying the collection of the data considered here gave more emphasis to the social skills involved in classroom management than to the logical and cognitive aspects of learning. Other researchers using some of this data have found potentially important associations between the indirectness of a teacher's verbal influence and the attitudes and academic achievements of students.

Research relating classroom management and student ability variables to achievement and attitude yielded substantially consistent results. That is, those variables which concerned student-centered activities and student freedom to participate, manage, and act were usually related to student attitudes, and student abilities always had strong associations with academic achievement. Also, a few of the studies found associations between teacher influence variables and student achievement. However, the associations with achievement were not always consistent.

Research on the relation between achievement and attitude provided strong support for the contention that student attitudes (i.e. personal-social achievement) can be fairly independent of academic achievement.

The section on the relation of the data to learning theory contained summaries of learning principles involving the variables considered in this study. These summaries gave some theoretical support to the importance of interaction variables in determining student achievement.

The review of relevant predictive studies suggested that previous achievement and other intellective factors are by far the best predictors of future achievement. However, there was some support for the statement that measures on socio-psychological variables can increase the power of intellective variables in predicting academic achievement.

The research reviewed and summarized in this chapter had many implications for the development of this paper. Most significantly, it provided guidelines for the selection of interaction variables to be considered and information regarding what other researchers have learned about classroom variable relationships which are directly related to those investigated here.

CHAPTER III

RESEARCH DESIGN

In this chapter the specific hypotheses and questions are stated, the sample is described, and the variables investigated are named, defined and discussed. The chapter concludes with a description of the procedures used to accomplish the proposed objectives and a consideration of some limitations of the research design.

Hypotheses and Questions

The learning activities for which data were gathered represented three very diverse classroom situations consisting of 29 sixth grade elementary, 15 seventh grade social studies, and 16 eighth grade mathematics classes. Therefore, it was decided to carry out a primary analysis on all three grade levels combined and a secondary analysis on individual grade levels. This order of emphasis was a result of the small number of within grade level observations compared to the number of variables investigated. The decision to engage in the secondary analysis at all was based on the assumption that those verbal interaction variables which may be associated with the learning of eighth grade mathematics are not necessarily the same as those relating to general sixth grade achievement. At the same time analyses for all grade levels combined were needed to determine whether or not specific independent-dependent variable relationships were consistent across the three different teaching-learning situations.

As a result of the individual and combined grade level analyses and of the large number of variables considered, the number of specific hypotheses tested and questions answered was enormous. Over 700 F ratios, 720 estimated strengths of association, hundreds of regression equations, a multitude of correlation coefficients, and several quadratic and cubic trend analyses were determined. Consequently, the hypotheses to be tested and questions to be answered are all stated in the form of encompassing questions rather than narrow hypotheses. Questions one through eleven were answered for each of the three grade levels separately (29 sixth grade classes, 15 seventh grade classes, and 16 eighth grade classes) and for all three grade levels (60 classes) combined.

The specific questions considered are:

1. What are the intercorrelations among all of the variables in Table 6?
2. Which of the 30 independent variables have statistically significant over-all associations with the academic achievement of students?
3. Which of the 30 independent variables have statistically significant over-all associations with the attitudes of students?
4. Which significant over-all associations are linear and which are curvilinear?
5. Which significant curvilinear associations are quadratic and which are cubic?
6. What are the proportions of variance due to linear, curvilinear, and over-all regression with achievement which are accounted for by each of the 30 independent variables?

7. What are the proportions of variance due to linear, curvilinear, and over-all regression with attitudes which are accounted for by each of the 30 independent variables?

8. What combination of independent variables is generated as the best predictor of achievement in the multiple linear regression equation?

9. What is the proportion of variance due to linear regression with achievement which is accounted for by the best predictive combination of variables?

10. What combination of independent variables is generated as the best predictor of attitudes in the multiple linear regression equation?

11. What is the proportion of variance due to linear regression with attitudes which is accounted for by the best predictive combination of variables?

12. What is the nature of the operative computer model developed here which simulates some aspects of an educational process?

Description of Sample

Since the writer was not a member of the research teams which selected the samples used in this study, the following description is based entirely upon the reports of other persons. References for this section consisted of articles written by Flanders (1965) and Morrison (1966).

The data used in this study were obtained from 15 seventh grade social studies classes and 16 eighth grade mathematics classes in the Minneapolis-St. Paul area and from 29 sixth grade elementary classes within a sixty mile radius of the Detroit area.

From the total population of 63 seventh grade social studies classes and 85 eighth grade mathematics classes, 50 classes from each subject area were selected at random. Teachers in 37 of the social studies classes and 38 of the mathematics classes agreed to participate in a special two week study unit.

Because the Minnesota Student Attitude Inventory (MSAI) has been shown to have a significant association with teacher influence (Flanders, 1965), it was administered to each of the 50 participating classes to further subdivide the sample into classes representing a wide range of teacher influence. In Minnesota the top and bottom eight classes on the MSAI were selected for two week study units.

Measures of achievement and attitude before and after the two week study units, and measures on verbal interaction variables during the two week study units constituted the seventh and eighth grade raw data used in this study.

Of 101 participating sixth grade classes in the Detroit metropolitan area, 30 were selected for interaction analysis observations. The 30 classes were selected according to their scores on an adapted form of the MSAI. Ten high, middle, and low scoring classes were chosen. Measures on the Michigan classes consisted of 8-10 hours of interaction analysis observations and pre- and post-achievement and attitude tests. One class was dropped from this study because of an absence of I.Q. scores.

The technique of interaction analysis observation is presented in Appendix A, and the pre and post criteria measures are discussed in the next section.

Description of Variables

Decisions regarding which interaction variables to investigate were based primarily upon the research reported in the preceding chapter. Many of those reports suggested that the verbal interaction variables most likely to be associated with student attitudes and in some cases student achievements are those which relate to expansion vs. restriction of student freedom of action. The learning principles stated by Hough (1964) and Hilgard (1956) offered further suggestions about potential relationships between a teacher's verbal influence and student achievement. Finally, some variables were selected in order to check for possible associations between a dimension of content emphasis by the teacher and student attitudes and achievements.

Definitions

The specific variables selected for investigation are named and defined in Table 6. For those who are unfamiliar with interaction analysis, the discussion in Appendix A will facilitate understanding of the following definitions.

TABLE 6

Variable Definitions

Independent Variable	Name	Definition
V_1	Pre-Achievement	THEORETICAL--knowledge of content material before interaction analysis observations; OPERATIONAL--scores on Form A of the Metropolitan Achievement Test (MAT) for 29 sixth grade classes in Michigan; scores on tests developed by an interaction analysis research team for the 31 classes in Minnesota.
V_2	Pre-Attitude	THEORETICAL--student's attitudes toward the teacher, the teacher's method of teaching, and classroom activities in general before observation; OPERATIONAL--scores on the Minnesota Student Attitude Inventory (short form) for the 31 classes in Minnesota; scores on the Michigan Student Questionnaire for the 29 classes in Michigan.
V_3	I.Q.	THEORETICAL--ratio of mental age to chronological age; OPERATIONAL--scores on the Kuhlmann-Finch test of intelligence for the 31 classes in Minnesota; scores on a number of different standardized I.Q. tests for the Michigan classes.

Table 6 - continued

Independent Variable	Name	Definition
V_4	i/d ratio	THEORETICAL--ratio of expansive activity (percentage of time teacher spends accepting student feelings, praising students, and accepting student ideas) to restrictive activity (percentage of time spent giving directions, criticizing students, or justifying teacher authority)· OPERATIONAL--ratio of the number of tallies in columns 1-3 of a 10 by 10 matrix to the number of tallies in columns 6 and 7 (ratio of area A to area B of figure 1).
V_5	Flexibility	THEORETICAL--teacher's ability to adapt her verbal influence to different teaching-learning situations; OPERATIONAL--the arithmetic difference between the largest i/d ratio over all time use categories (e.g., administrative routine, evaluation, work, new material, discussion) and the smallest i/d ratio for all time use categories.
V_6	i/(i+d) ratio	THEORETICAL--ratio of expansive activity to expansive activity plus restrictive activity; OPERATIONAL--ratio of the number of tallies in columns 1-3 to the number of tallies in columns 1-3, 6, and 7(ratio of area A to area A+B of figure 1).
V_7	I/D ratio	THEORETICAL--ratio of indirect activity (expansive activity plus percentage of time used for teacher questions) to direct activity (restrictive activity plus percentage of time used for teacher lecture); OPERATIONAL--ratio of the number of tallies in columns 1-4 to the number in 5-7 (ratio of area C to area D of figure 1).

Table 6 Continued

Independent Variable	Name	Definition
V_8	I/(I+D) ratio	THEORETICAL--ratio of indirect activity to indirect activity plus direct activity; OPERATIONAL--ratio of the number of tallies in columns 1-4 to the number in 1-7 (ratio of area C to area C+D of figure 1).
V_9	Expansive Activity	THEORETICAL--percentage of verbal classroom interactions in which teacher accepts student feelings, praises students, or accepts student ideas; OPERATIONAL--percentage of tallies in columns 1-3 (area A of figure 1).
V_{10}	Restrictive Activity	THEORETICAL--percentage of time used to give directions, criticize students, or justify teacher authority; OPERATIONAL--percentage of tallies in columns 6 and 7 (area B of figure 1).
V_{11}	Indirect Activity	THEORETICAL--percentage of time used to accept student feelings, praise students, accept student ideas, or ask questions of students; OPERATIONAL--percentage of tallies in columns 1-4 (area C of figure 1).
V_{12}	Direct Activity	THEORETICAL--percentage of time used to lecture, give directions, criticize students, or justify teacher authority; OPERATIONAL--percentage of tallies in columns 5-7 (area D of figure 1).

Table 6 Continued

Independent Variable	Name	Definition
V_{13}	Teacher Talk	THEORETICAL--percentage of time in which teacher talks; OPERATIONAL--percentage of tallies in columns 1-7 (area C+D of figure 1).
V_{14}	Directed Student Response	THEORETICAL--percentage of time that students attempt to respond to and in conformance with teacher initiated ideas and statements; OPERATIONAL--percentage of tallies in column 8 (area E of figure 1).
V_{15}	Student Initiated Response	THEORETICAL--percentage of time in which students verbally initiate their own thoughts and concerns; OPERATIONAL--percentage of tallies in column 9 (area F of figure 1).
V_{16}	Student Talk	THEORETICAL--percentage of time in which students are talking; OPERATIONAL--percentage of tallies in columns 8 and 9 (area G of figure 1).

Table 6 Continued

Independent Variable	Name	Definition
V_{17}	Small Vicious Circle	THEORETICAL--percentage of time in which the teacher follows the giving of directions with student criticisms and follows criticisms with more directions; OPERATIONAL--percentage of tallies in the (6, 7) and (7, 6) cells (area H+I of figure 1).
V_{18}	Big Vicious Circle	THEORETICAL--percentage of time in which teacher follows the giving of directions with student criticisms, follows criticisms with more directions, or engages in the sustained giving of directions or sustained criticism; OPERATIONAL--percentage of tallies in the (6, 6), (6, 7), (7, 6), and (7, 7) cells (area H, I, J, and K of figure 1).
V_{19}	Rebellion	THEORETICAL--percentage of time in which students do not comply with teacher directions and criticisms; OPERATIONAL--percentage of tallies in the (6, 9) and (7, 9) cells (area L of figure 1).
V_{20}	Teacher Questions	THEORETICAL--percentage of time which teacher uses to ask questions; OPERATIONAL--percentage of tallies in colunn 4 (area O of figure 2).

Table 6 Continued

Independent Variable	Name	Definition
V_{21}	Teacher Lecture	THEORETICAL--percentage of time in which the teacher lectures; OPERATIONAL--percentage of tallies in column 5 (area P of figure 2).
V_{22}	Content	THEORETICAL--percentage of time in which the teacher either asks questions or lectures; OPERATIONAL--percentage of tallies in columns 4 and 5 (area 0+P of figure 2).
V_{23}	Content Cross	THEORETICAL--percentage of time during which teacher questioning or lecturing either precedes or follows other activities plus the percentage of time spent in sustained questioning or lecturing; OPERATIONAL--percentage of tallies in columns 4 and 5 plus the percentage in the (4, 1), (4, 2), (4, 3), (4, 6), (4, 7), (4, 8), (4, 9), (4, 10), (5, 1), (5, 2), (5, 3), (5, 6), (5, 7), (5, 8), (5, 9), and (5, 10) cells (area M of figure 1).

Table 6 Continued

Independent Variable	Name	Definition
V_{24}	Drill	THEORETICAL--percentage of time during which teacher asks question, students respond, more questions, etc.; OPERATIONAL--percentage of tallies in the (4, 8) and (8, 4) cells (area Q+R of figure 2).
V_{25}	Lecture plus Drill	THEORETICAL--percentage of time spent in lecture and drill; OPERATIONAL--percentage of tallies in column 5 plus the percentage in the (4, 8) and (8, 4) cells (area P, Q, and R of figure 2).
V_{26}	Sustained Acceptance	THEORETICAL--percentage of time in which the teacher engages in sustained acceptance or use of student ideas; OPERATIONAL--percentage of tallies in the (3, 3) cell (area S of figure 2).
V_{27}	Sustained Expansive Activity	THEORETICAL--percentage of time in which the teacher is engaged in sustained acceptance of student feeling, praise of students, or acceptance or use of student ideas; OPERATIONAL--percentage of tallies in the (1, 1), (1, 2), (1, 3), (2, 1), (2, 2), (2, 3), (3, 1), (3, 2), and (3, 3) cells (area N of figure 1).

Table 6 Continued

Independent Variable	Name	Definition
V_{28}	Praise	THEORETICAL--percentage of time during which the teacher praises students OPERATIONAL--percentage of tallies in column 2 (area T of figure 2).
V_{29}	Reward	THEORETICAL--percentage of time in which student responses are rewarded (e. g. followed by expansive activity); OPERATIONAL--percentage of tallies in the (8, 1), (8, 2), (8, 3), (9, 1), (9, 2), and (9, 3) cells (area U of figure 2).
V_{30}	Restrictive Feedback	THEORETICAL--percentage of time in which student responses are followed by restrictive activity; OPERATIONAL--percentage of tallies in the (8, 6), (8, 7), (9, 6), and (9, 7) cells (area V of figure 2).

Dependent Variable	Name	Definition
V_{31}	Post-Attitude	THEORETICAL--students' attitudes toward the teacher, the teacher's method of teaching, and classroom activities in general after the interaction analysis observations; OPERATIONAL--scores on the Minnesota Student Attitude Inventory (long form) for the 31 classes in Minnesota; scores on the Michigan Student Questionnaire for the 29 classes in Michigan.

Table 6 continued

Dependent Variable	Name	Definition
V_{32}	Post-Achievement	THEORETICAL--knowledge of content material after the interaction analysis observations; OPERATIONAL--scores on Form B of the Metropolitan Achievement Test (MAT) for the 29 sixth grades on tests developed by an interaction analysis research team for the 31 classes in Minnesota.

Discussion

The purpose of this section is to expand upon some of the necessarily brief definitions in Table 6, to comment on the interrelationships among some of the variables, and to provide a rationale for some of the variable selections.

Since observations of the sixth grade classes in Michigan did not cover a specific unit of study, a very general measure of achievement was used. The pre- and post-achievement measures used in this paper consisted of a composite of five sub-tests from the Metropolitan Achievement Test (MAT). One sub-test was itself a language composite of usage, parts of speech, punctuation, and capitalization. The other four sub-tests were language study skills, arithmetic computation, arithmetic problem solving concepts, and social studies study skills. The study skills related to one's ability to locate and use reference information,

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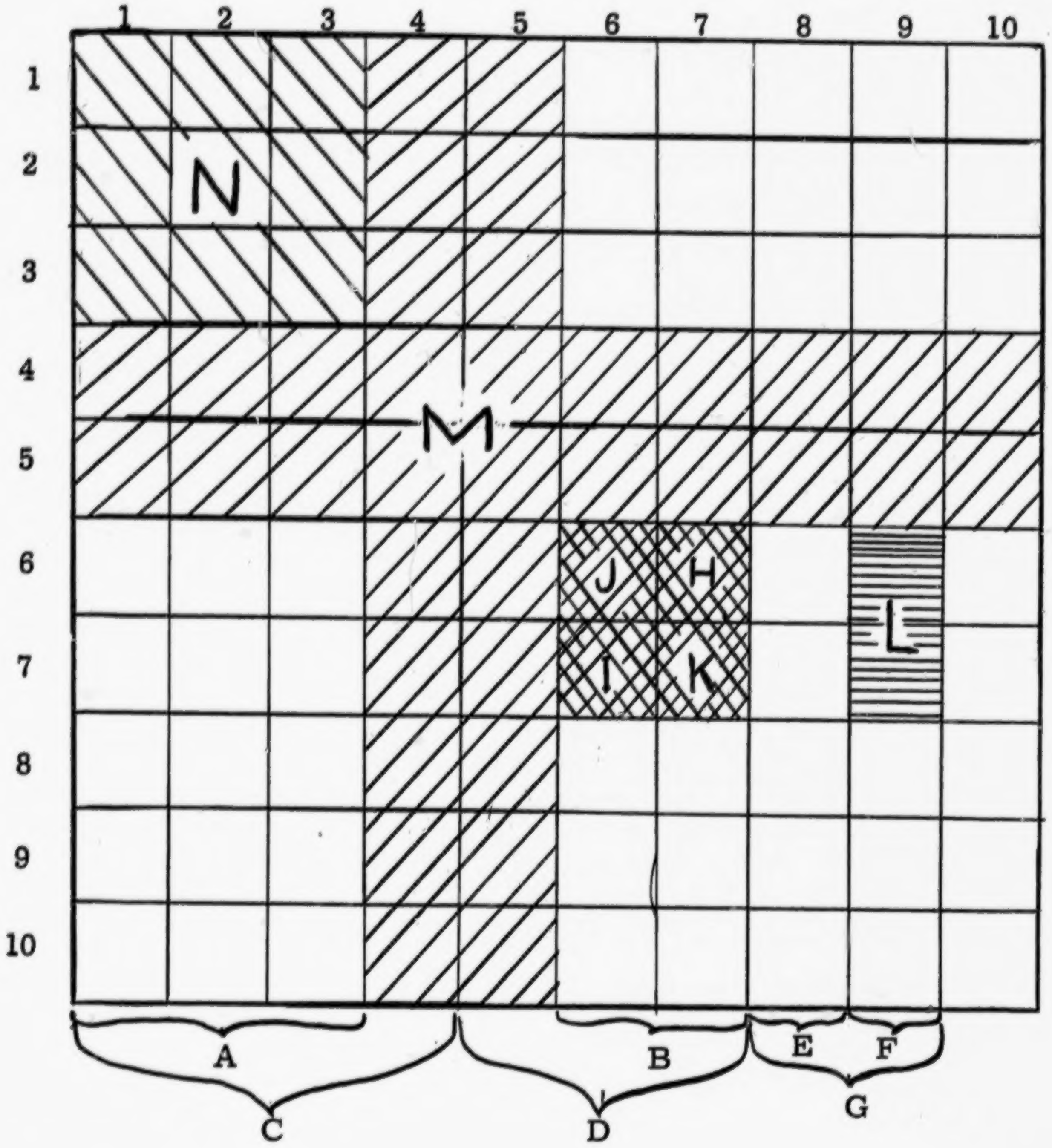
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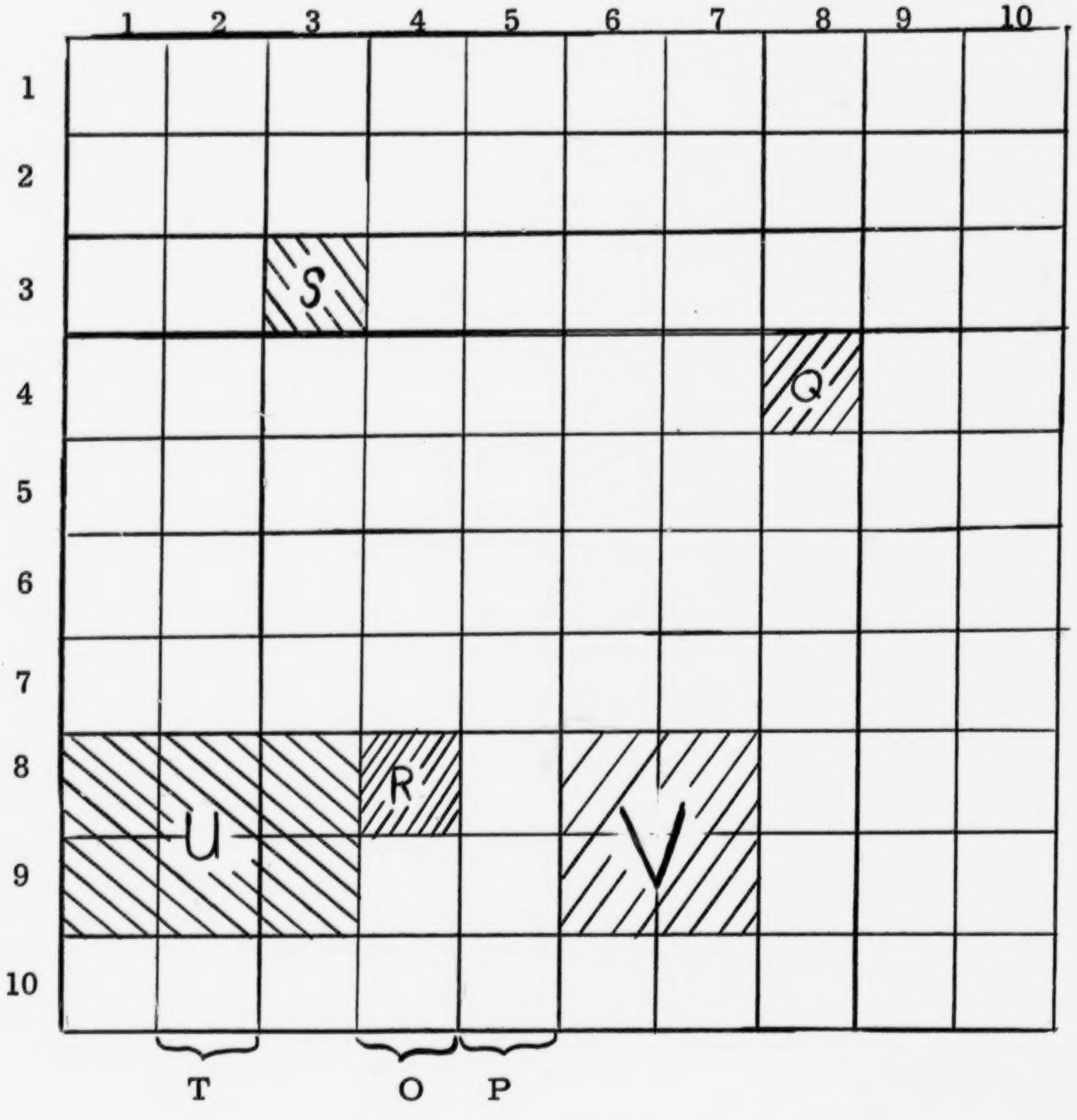
G

figure 1

Pictorial Definitions (One)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Pictorial Definitions (Two)

figure 2

and the arithmetic skills concerned computation and problem solving abilities. The MAT Manual reports median split-half reliability coefficients for each sub-test ranging from .72 to .94. These coefficients were based on random samples of 100 students from four independent school systems. More detailed descriptions of the characteristics of the MAT are contained in the dissertation by Morrison (1966) and the MAT Manual.

The Minnesota interaction analysis observations were made two days at the beginning, middle, and end (6 days) of a ten day teaching period. During this time, the seventh grade social studies classes studied a unit on New Zealand and the eighth grade mathematics classes studied a unit of ninth grade or higher mathematics. Therefore, research teams developed special purpose tests to measure academic achievement for the two week study units and used the tests to measure both pre- and post-achievement. Flanders' (1965) description of the achievement tests developed under his direction is presented below.

> "The test on New Zealand consisted of (a) 22 true-false statements about the government, economy, and geography; (b) 24 multiple-choice questions covering the same topics; (c) a matching item on climate; (d) a problem-solving item on the latitude and longitude of a New Zealand city; and (e) 10 items requiring the student to apply principles of economic trade or land use learned about New Zealand to a fictitious island. These last items required transfer of learning in the sense of problem-solving in a new context.
>
> The unit of study in eighth-grade geometry (and algebra) was essentially ninth-grade or higher math content, taught at least 1 year early. It deals with applications of certain formulas:

> first, the formula for the circumference of a circle--$C = \pi d$; second, the distance, speed, and time formula--$D = RT$; and third, several formulas involving inscribed angles. Basic concepts and understandings prerequisite to the foregoing were also taught.
>
> The test of achievement consisted of (a) 22 items requiring a solution of a single unknown in a simple equation; (b) 10 similar items with 2 unknowns; (c) 15 items concerning geometric figures and requiring the student to find unknown angles; (d) 10 items consisting of word problems requiring application of formulas involving speed, distance, and time over geometric "routes", and (e) 5 items which presented unique applications of the content taught. Many items among the last 15 mentioned required the student to apply principles to a problem context different from the ones encountered in his initial learning experience."

The Minnesota Student Attitude Inventory (MSAI) was the result of several years of research. Initially, the Hoyt-Grimm Pupil Attitude Inventory was administered and item analyzed. Those items which discriminated between top and bottom groups by total score based on an arbitrary key were retained, items which failed to discriminate were discarded, and new items were added. This cycle was repeated four times during a six year period resulting in the MSAI long form used as the post-attitude test in the Minnesota studies.

The MSAI required students to respond on a five point scale to 62 items. Basically, the items related to teacher attractiveness, motivation, rewards, and punishments. Sample questions were: "Would you like to have this same teacher next year?", "Is the teacher quick to say something nice when you do well?", "Is your teacher too bossy?" and "Do you get along well with your teacher?"

The reliability of the MSAI varied from .68 to .93 and had a median of .85. The validity of the test was established by its success in identifying classroom situations where patterns of teacher influence were significantly different.

The Michigan Student Questionnaire (MSQ) was the product of yet another revision of the MSAI. Both tests measured pupil perceptions of teacher attractiveness, motivation, rewards, and punishments. But only the MSQ included items referring to teacher competence. Examples of items related to teacher competence are: "This teacher is good at thinking things through," "This teacher is quick to see what mixes you up in your schoolwork," and "This teacher knows a lot." Other discussions of the MSAI and MSQ can be found in the writings of Flanders (1965) and Morrison (1966).

As a group, variables 1-3 (pre-achievement, pre-attitude, and I.Q.) represent classroom factors which are uncontrollable during the brief course of a given teaching-learning situation. The association between pre- and post-attitude scores should give some indication of how stable student attitudes were throughout the observation period. I.Q. and pre-achievement relate to a kind of capacity to achieve academically and can be expected to have strong associations with the dependent variable of post-achievement.

The remaining variables relate to classroom verbal interaction patterns and are somewhat controllable by the teacher. A frequently investigated verbal interaction variable is the i/d ratio (V_4) which other studies have used to operationalize the directness or indirectness of teacher influence and which has had fairly reliable associations with both the attitudes and achievements of students. The terms "expansive activity" and "restrictive activity" used in the definition of the i/d ratio were coined for this study and require an elaboration.

In Table 2 categories 1-4 refer to indirect teacher influence and categories 5-7 refer to direct teacher influence. The writer felt that the deletion of category 4 (teacher questioning) from the indirect influence categories results in a set of categories which is more strongly related to the expansion of student freedom to act than is indirect influence. Hence, activities described by categories 1-3 (accepts feeling, praises or encourages, and accepts or uses student ideas) are said to be expansive in this study. In a like manner categories 6 and 7 seem to be more strongly related to the restriction of student freedom to act than does the composite of direct categories 5, 6, and 7. Therefore, that variable which represents the percentage of time spent giving directions, criticizing students, and justifying teacher authority is called restrictive activity here.

The method of quantifying flexibility is quite crude and probably not an accurate measure of the theoretical definition. However, the use of the range of i/d ratios across time use categories as a measure of flexibility is identical to the method used in the Minnesota studies and thus enables the writer to more readily relate the results of this research to other relevant studies. At the present time researchers at the University of Michigan are trying to discover a more valid way of operationalizing what is theoretically meant by flexibility.

Since it was feared that d in the i/d ratio might approach zero for some observational periods and thus cause i/d to approach infinity, i/(i+d) ratio was also considered. The i/(i+d) ratios have the same rank orders as corresponding i/d ratios but a potential range of only zero to one instead of zero to infinity.

The ratio of indirect to direct activities (I/D ratio) was considered here because of its simultaneous relationship to the two major divisions of teacher influence. The I/(I+D) ratio was added to the list of variables to be investigated for exactly the same reason as was the i/(i+d) ratio.

The reasons why variables nine through sixteen were of interest are fairly self evident from the names and definitions in Table 6. Each of these variables pertains to a different dimension of student freedom to participate. V_9 and V_{11} represent activities which encourage student participation and thought while V_{10} and V_{12} concern emphases on teacher ideas and demands. At the same time V_{11} and V_{12} are much more content oriented than are V_9 and V_{10}. Even though V_{14} and V_{15} pertain to student responses, V_{14} is still quite teacher-center while V_{15} relates to students' very own ideas and contributions. The gross dimensions of student talk (V_{16}) and teacher talk (V_{13}) are studied here in the event that the quantity rather than or in addition to the quality of teacher or student talk is related to student attitudes and achievements.

Measures on V_{17}, V_{18}, and V_{19} pertain to three different aspects of the extent to which students are not complying with teacher demands. It was hoped that an analysis using these variables would relate some problems of classroom discipline to student attitudes and achievements. Tallies in the small vicious circle (V_{17}) depict rapid changes from giving directions to criticizing, giving more directions, more criticisms, etc. The big vicious circle (V_{18}) should apply to activities which are not so chaotic as those represented by V_{17} because many of the directions and criticisms in V_{18} are at least sustained. Although certain student activities may be inferred from measures on the small and big vicious circle the rebellion variable (V_{19}) deals directly with the nature of student responses to authority by ascertaining the extent to which teacher demands and criticisms are followed by student initiated ideas.

Because variables twenty through twenty-five relate to teacher questioning, lecturing, and drilling, they are highly content oriented. They were considered in this study because of the writer's interest in the nature of associations between a teacher emphasis on content and student attitudes and achievements.

V_{26} and V_{27} represent a much more sincere acceptance of student ideas and expansion of student freedom to express ideas than do V_9 and V_{11}. Superficial statements such as "um-huh", "that's interesting", etc. would be quantified as expansive activity (V_9) but not as sustained acceptance (V_{26}) or sustained expansive activity (V_{27}). Expansive or acceptive activities must last more than three seconds to be tallied in the areas represented by V_{26} and V_{27}.

Finally, many of the learning principles and studies cited in the preceding chapter suggest that those variables called praise (V_{28}), reward (V_{29}), and restrictive feedback (V_{30}) might be associated with both the attitudes and academic achievement of students.

Procedures

The procedures used to answer the questions posed to the first section of this chapter consisted of two different tasks. One task was to analyze data in an attempt to learn something about the nature of the independent-dependent variable associations. The other was to develop a computer model which simulated certain aspects of the relationships among classroom variables. All of the procedures described in the remainder of this section were carried out for each grade level separately and also for all three grade levels combined unless stated otherwise.

Data Analysis

Each of the verbal interaction variables were quantified by obtaining appropriate matrices and calculating the values represented by the operational definitions of Table 6. Measures of achievement, attitude, and I. Q. were found by calculating class average scores on the paper and pencil instruments described in the preceding section.

Since measures of achievement, attitude, and I. Q. were obtained by a different instrument in each of the three different grade levels, values of the mean, standard deviation, and range for any one of these variables were highly dependent upon the grade level considered. Therefore, the writer wrote a computer program which changed all measures of achievement, attitude, and I. Q. into standardized T-scores. The standardized T-score program was later adapted to print out means, standard deviations, and ranges on all 32 variables.

It was not necessary to standardize scores on the verbal interaction variables because these scores were obtained by reliable observers using identical procedures in each grade level. The observation procedures were those discussed under the description of the data in Appendix A, and all observers had a Scott Index (1955) reliability coefficient of at least .85.

An important part of the statistical analysis involved the single factor, fixed effects analysis of variance model. In this model an F ratio is calculated by finding the ratio of the between group variance to the within group variance. But if each observed value of an independent variable used in this study was considered as a level of that variable for the analysis of variance model, then there would be no within group variance with which to compare the between group variance. That is, there would be only one observation for each level of a variable. Therefore, it was necessary to create within group variances by grouping values of independent variables into meaningful sample levels. The method used on each of the 30 independent variables was to rank order the observed values for a variable and then group the rank ordered observations into quartile levels. The quartile levels then served as the level of the independent variable for the analysis of variance model.

Some of the statistical analyses were considerably facilitated by computer programs developed by other people. The intercorrelations among all 32 variables were generated by a program on tape at The University of Michigan Computing Center. The same program was used to determine the correlations between independent variable quartile levels and the dependent variables of student attitudes and achievements. Another program written by M. C. Johnson at The University of Michigan Computing Center was used to calculate over-all F ratios for the single factor, fixed effects, analysis of variance model.

Partial correlations between each independent variable and Post-Achievement and Post-Attitude with Pre-Achievement and Pre-Attitude respectively held constant were determined by a formula from Walker and

Lev (1953, p. 342). The formula is:

$$r_{Y3\cdot 2} = \frac{r_{13} - r_{12} r_{32}}{\sqrt{1 - r_{12}^2}\ \sqrt{1 - r_{32}^2}}$$

The writer developed special programs to determine the significance of linear regression, the significance of curvilinear regression, the linear strength of association (ρ^2), the curvilinear strength of association ($\omega^2 - \rho^2$), and the over all strength of association (ω^2). The basic formulas used in the programs were taken from Hays (1963) and are as follows:

$$\text{S S Linear Regression} = \frac{N\left(\Sigma_i \Sigma_j X_j Y_j - (\Sigma_j n_j X_j)(\Sigma_i \Sigma_j Y_{(ij)}) / N\right)^2}{N(\Sigma_j n_j X_j^2) - (\Sigma_j n_j X_j)^2}$$

$$\text{F (Linear Regression)} = \frac{\text{M S Linear Regression}}{\text{M S error}}$$

$$\text{F (Curvilinear Regression)} = \frac{\text{M S Curvilinear Regression}}{\text{M S error}}$$

$$\text{estimated } \rho^2 = \frac{\text{S S Linear Regression} - \text{M S error}}{\text{S S total} + \text{M S error}}$$

$$\text{estimated } (\omega^2 - \rho^2) = \frac{\text{S S Curvilinear Reg.} - (J-2) \text{ MS error}}{\text{S S total} + \text{M S error}}$$

$$\text{estimated } \omega^2 = \frac{\text{S S between} - (J-1) \text{ M S error}}{\text{S S total} + \text{M S error}}$$

In these formulas S S is sum of squares, M S is mean square, J is the number of groups, X_j is a sample level, Y_{ij} is a dependent variable score, N is the total number of observations, and n_j is the number of observations in group j.

Where curvilinear trends were significant additional trend analyses discussed by Ray (1960) were used to determine the significance of quadratic and cubic associations. The formulas taken from Ray were:

$$F \text{ (Quadratic Regression)} = \frac{(A_4 - A_3 - A_2 + A_1)^2/4n}{M\ S\ \text{error}}$$

$$F \text{ (Cubic Regression)} = \frac{(A_4 - 3A_3 - 3A_2 - A_1)^2/20n}{M\ S\ \text{error}}$$

where the A_i's are the sums of the dependent scores for the various quartile levels and n is the number of observations per group.

A stepwise regression program developed by F. H. Westervelt at The University of Michigan Computing Center was used for the regression analysis. The purpose of the regression program is to generate β coefficients in a multiple linear regression equation of the form:

$$X_1' = \beta_{12} X_2 + \beta_{13} X_3 + \ldots + \beta_{1k} X_k + C$$ where X_2 through X_k are the predictor variables and X_1 is the dependent variable. Predictor variable standardized scores were used in the regression analyses so that the β coefficients would represent standard partial regression coefficients indicating relative predictive strengths. This stepwise regression procedure generates the equation, variable by variable, in order of relative importance until all significant variables are included. The level of significance is specified by the user.

For reasons to be discussed later in this chapter, the multiple correlation coefficients generated by the stepwise regression analyses were biased estimates of the corresponding population parameters. McNemar's (1962) correction for shrinkage formula was used in some cases to calculate unbiased estimates of the multiple correlation coefficients in the population.

This formula is:

$$R'_{1\cdot 23\ldots n} = \sqrt{1 - (1-R^2_{1\cdot 23\ldots n})\left(\frac{N-1}{N-n}\right)}$$

where n is the number of variables, N is the number of observations, and R^2 is the coefficient of determination for the sample. Of course, as N becomes very large and n becomes small $R_{1\cdot 23\ldots n}$ approaches the value of $R'_{1\cdot 23\ldots n}$.

Model Development

In line with Dawson's definition of simulation in Chapter 1, it was decided to first of all develop an appropriate model and then use the digital computer to make the model operative. The model would be exploratory and could not be reality checked in all respects by the data of this study.

Perhaps a distinction between model and theory is needed at this time. To paraphrase Kaplan (1964, chapt. 7), a theory states that a system has a certain structure while a model exhibits that structure itself. The model developed here exhibits some empirical properties of and relationships among certain factors of a classroom learning situation and says nothing about the cause-effect structure of any theory of instruction.

The review of related literature in Chapter II indicated that the literature of educational research often contains seemingly contradictory results. Consequently, the writer did not feel justified in using educated guesses based upon research results as constants for any of the invariable processes of the simulated system.

The decision to use only empirical data was an attempt to deal with the problem of model fidelity by including a kind of empirical reality check in the construction of the model. This emphasis on empirical support for the model seems to be upheld in the writings of Bushnell (1962), Beaird (1964), and Dawson (1962).

> "Transfer effects or generalizations are determined to a great extent by the exactness of the simulation." ---Bushnell
>
> "Here the problem is one of designing a model which accurately produces behavior similar to that of the system being modeled." ---Beaird
>
> "The important factor is that the components and variables being investigated through the model respond in a manner comparable to that of the behavior of the real system." ---Dawson

Many computer simulations analyze input conditions and then generate outcomes as certainties. These simulations assume that a given combination of predictor variables will always produce the same result. The assumption is occasionally justified for certain industrial processes and simple problem solving. However, the teaching-learning process which goes on in the classroom does not appear to be in such a deterministic state.

In discussing simulation models for education, Fattu (1965) says, "It is not like the physicist discovering principles of elegant simplicity; it is more like the systems engineer trying to predict the behavior of a complex system reacting to many variables concurrently. The prediction thus tends to be probabalistic rather than deterministic." Johnson (1964) suggests that "a computer model of psychological processes should be capable of assigning changeable probabilities to outcomes." That is, various combinations of teacher-learner variables should produce probabalistic outcomes. Such an approach was used to develop the model proposed here.

If the laws of arithmetic apply to some of the empirical relationships within a system, then a mathematical model or arithmetic representation, as discussed by Brodbeck (1963), may serve as a model which exhibits some substructure of the system. Because of the quantitative nature of the variables considered here, it was decided that multiple linear regression equations were sufficient to serve as the foundation of the model.

Unlike most of the analyses carried out in this paper, the computer model applies only to the general educational process represented by all sixty classes combined. The regression equations for individual grade levels yielded multiple correlation coefficients which were highly biased in the positive direction and, therefore, could not be used in the model. The reason for this biased estimate was the relatively high ratio of predictor variables to observations and is discussed further in the next section under limitations of the study.

Regression analyses on the combined data provided two prediction equations (one for achievement and one for attitude) which were then revised to yield probabalistic distributions of dependent variable scores for all simulation runs. The revision used theoretical samples from some predefined range of values which were distributed around the predicted score and whose limits were determined by the standard error of prediction. That is, scores were sampled from a normal distribution with a mean equal to the predicted score and a standard deviation equal to the standard error of prediction. The probability with which a given dependent score is chosen is determined by the area under the curve which is bounded by the upper and lower real limits of the score.

If the user of the program specifies various levels for independent variables, then the model will generate a probabilistic, but realistic, distribution of thirty dependent variable class scores, the mean and standard deviation of the probabalistic distribution, a 95% confidence interval and percentile rank for the mean and t ratios which reflect the significance of differences between dependent variable means for pairwise comparisons of different combinations of independent variable levels.

Results of the analyses used to satisfy the first four objectives of Chapter I indicated which variables were good enough predictors of student achievements and attitudes to be included in the model. A complete description of the model is contained in the next chapter.

Limitations

One important limitation of this study concerns the fact that some of the results reported may be misinterpreted by some readers. Those misinterpretations which do occur are likely to be a result of the necessity of using class scores instead of individual scores for all subjects involved. An explanation for using class scores and some reasons why analyses using class averages can produce different results than identical analyses using individual scores will now be given.

Both students and the teacher have an effect on measures of interaction variables. Although a teacher can lecture as much as she wants, it is difficult for her to accept or use student ideas if no ideas are expressed. At the same time, the percentage of classroom activities represented by the various interaction variables does not have the same effect on all children in the class. For example, teacher praise of Johnny is likely to have a different effect on Johnny than on Jimmy. Therefore, the writer did not feel justified in applying scores on verbal interaction variables to each individual child. Rather, it was decided to treat interaction measures as class scores. One measure per class on each verbal interaction variable was obtained by the methods described in Table 6. The decision to work with class scores on interaction variables also required the use of averages for the achievement, attitude and I.Q. variables.

The use of the class score had two debilitating effects. One was to greatly reduce the within group variability, and the other was to reduce the size of the sample by a factor of about thirty. These effects were much more of a problem for the uncontrollable variables than for the interaction variables because the interaction variables had no within class variability to start with.

The reduction of the within group variability caused some of the correlations for means which appear in the next chapter to be much larger than the corresponding correlations for individuals. As an example consider Table 7 which contains selected correlations for both means and individuals.

TABLE 7

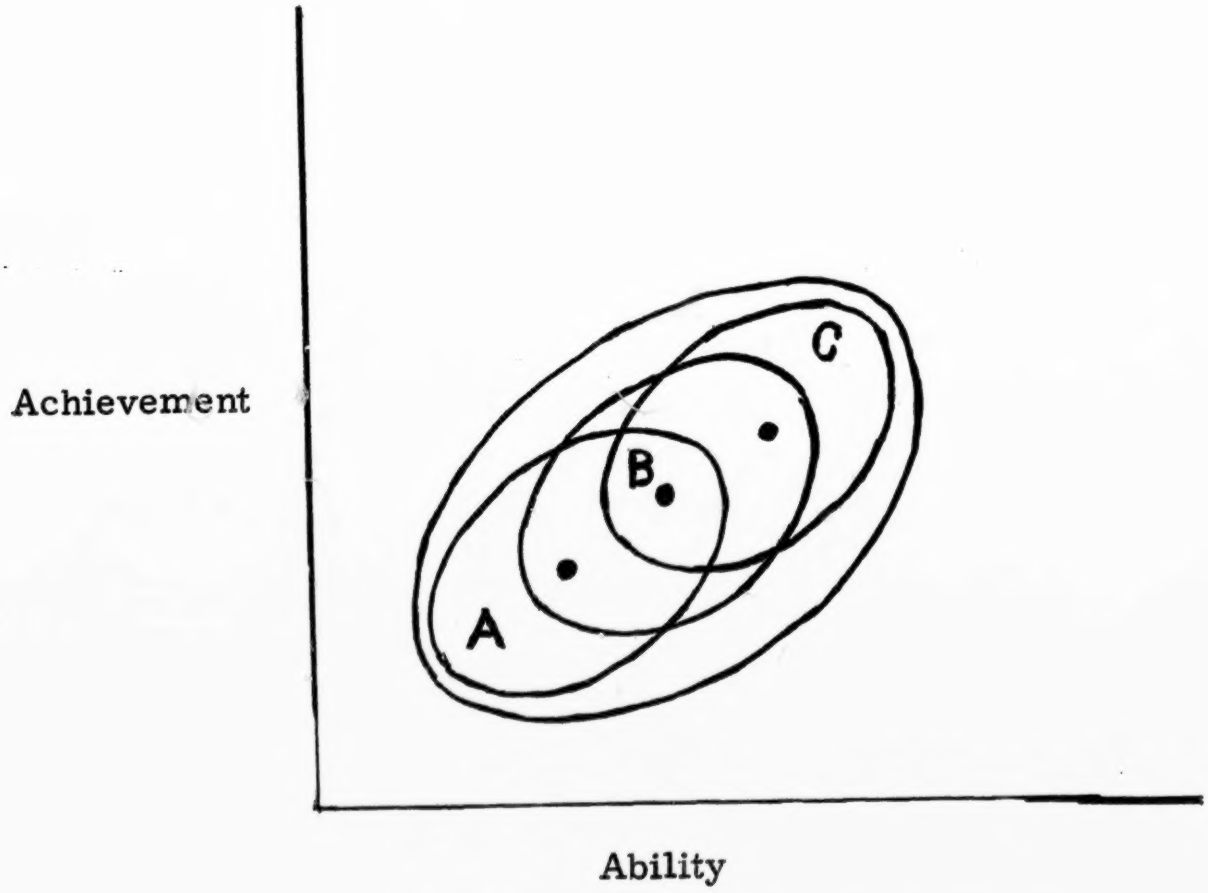
Correlation of Individuals Vs. Correlation of Means

	Pre- vs. Post-Achievement		I.Q. vs. Post-Achievement	
	Individuals	Means	Individuals	Means
7th grade	.62	.80	.58	.86
8th grade	.82	.92	.70	.88

Table 7 clearly illustrates the fact that inferences made from the results of this study will not necessarily apply to individual students.

Guilford (1965, p. 347-348) says that if one can assume random samples from homogenous populations, "the correlation between averages of samples is equal to the correlation between individual pairs of measurements." However, since the above assumption is rarely precisely satisfied in educational research, Guilford also talks about sampling conditions under which the correlation between means can be expected to differ from the one between individuals. His discussion indicates that correlations of the type calculated in this study between ability variables and post-achievement can be expected to be much higher than the corresponding correlations for individuals.

Figure 4, adapted from Guilford's discussion, provides an extreme but convincing example of how the phenomenon described above can occur. A, B, and C are scatter plots of ability vs. achievement for three different classes, and the dots form a scatter plot of the class means. The correlations among individuals for each class as well as for all classes combined appears to be about 0. 6 or 0. 7. However, the correlations for means is perfect.



Inflation of Correlation Coefficient

Figure 3

As indicated previously, if there were about 30 students per class, then the use of class instead of individual scores would reduce the sample size by a factor of about 30 and create a relatively high ratio of predictor variables to observations, since there would be 30 predictor variables, 29 sixth grade observations, 15 seventh grade observations, 16 eighth grade observations, and 60 observations for all grades combined. McNemar (1962) points out that if the number of variables (n) is equal to the number of observations (N), then the multiple correlation coefficient will be equal to unity regardless of the nature of the variables. Furthermore, he states, "As n approaches N, the value of the multiple r always approaches unity." He suggests that "when n is large relative to N, the real significance of an obtained multiple r is questionable. In other words, the multiple correlation coefficient is subject to a positive bias, the magnitude of which depends on the degree to which n approached N.

The ratio of n to N can be improved by either increasing N or decreasing n. In this study N was increased by considering all grade levels combined, and n was decreased by stopping the stepwise regression analysis at the eighth step. McNemars correction formula, stated earlier in the analysis section of this chapter, was used to further reduce the bias created by the high ratio of n to N.

Another limitation of the study is the redundancy of the information which was produced by the data analyses. The reason for the redundancy of the obtained information was the high intercorrelations (see Table 9 in the next chapter) among many of the independent variables. To get a more descriptive measure of redundancy, the writer used a taped computer program to carry out a factor analysis. The analysis indicated that the 30 predictor variables investigated constituted only seven truly independent factors.

The study might also be criticized because the variables considered minimize the importance of the logical and cognitive aspects of classroom behavior and because of the grossness of some of the categories.

Although the above limitations are acknowledged and regretted, the scope of the project had to be deliminited at some point. All of the factors affecting the performance of a class on an achievement or attitude test are simply too numerous and too complex to be investigated in a single study.

CHAPTER IV

RESULTS

This chapter presents descriptive measures of the samples, statistical evidence pertaining to the research questions, a summary and interpretation of all significant findings, and a description of the computer model.

Although analyses were performed for each grade level separately and all grade levels combined, results based on the combined grade level samples are emphasized in this chapter. This method of presentation was chosen because the number of observations in individual grade levels was very small in comparison to the number of variables studied. All separate grade level analyses not appearing in the text are presented in the appendix.

Descriptive Statistics

The descriptive statistics in this section should help clarify the nature of the inter-relationships among the variables defined in Table 6 and provide answers to the first of the twelve specific questions posed in the preceding chapter.

Variable Distributions

Table 8 contains the mean, standard deviation, and range of all variables considered. These summary statistics are included to give the reader some idea of how much classroom activity was associated with each of the interaction variables.

TABLE 8

Summary Statistics for Variable Distributions in all Grades Combined

Independent Variable	Name	Mean	S.D.	Range
V_1	Pre-Achievement	50	10	22.00-68.00
V_2	Pre-Attitude	50	10	31.00-67.00
V_3	I.Q.	50	10	25.00-70.00
V_4	i/d ratio	1.24	1.04	0.07- 5.1
V_5	Flexibility	2.58	3.28	0.09-15.12
V_6	i/(i+d) ratio	0.47	0.20	0.09- 0.84
V_7	I/D ratio	0.49	0.23	0.09- 0.94
V_8	I/(I+D) ratio	0.31	0.11	0.08- 0.49
V_9	Expansive Activity	7.29	3.08	0.98-14.77
V_{10}	Restrictive Activity	9.12	5.44	2.03-29.80
V_{11}	Indirect Activity	17.93	6.02	5.29-29.12
V_{12}	Direct Activity	40.76	12.33	21.00-73.22
V_{13}	Teacher Talk	59.13	11.53	37.10-82.33
V_{14}	Directed Student Response	18.09	9.55	2.89-51.45
V_{15}	Student Initiated Response	9.50	4.51	0.45-21.82
V_{16}	Student Talk	27.61	10.43	9.68-54.46
V_{17}	Small Vicious Circle	0.44	0.59	0.00- 4.05
V_{18}	Big Vicious Circle	3.89	3.15	0.50-17.07
V_{19}	Rebellion	0.70	0.73	0.00- 4.61
V_{20}	Teacher Questions	10.60	4.14	3.21-23.41
V_{21}	Teacher Lecture	31.62	12.78	12.95-63.52
V_{22}	Content	42.24	12.66	22.45-73.45
V_{23}	Content Cross	55.90	12.73	31.27-85.53
V_{24}	Drill	8.16	4.19	1.61-30.37
V_{25}	Lecture plus Drill	39.77	12.51	21.26-68.66
V_{26}	Sustained Acceptance	1.39	1.14	0.00- 5.48
V_{27}	Sustained Expansive Activity	1.80	1.33	0.08- 6.26
V_{28}	Praise	1.14	0.72	0.10- 3.76
V_{29}	Reward	4.86	2.07	0.25-10.15
V_{30}	Restrictive Feed-back	1.55	1.17	0.10- 5.02
Dependent Variable:				
V_{31}	Post-Attitude	50	10	31.00-67.00
V_{32}	Post-Achievement	50	10	22.00-66.00

Another function of the table relates to the interpretation of results. Some of the variables had a very low rate of occurrence. Activities represented by the Small Vicious Circle, Rebellion, Sustained Expansive Activity, Praise, and Restrictive Feedback occurred less than 1.6% of the time, on the average. Therefore, this study provides no information about associations involving extremely high values (e.g. 20%-30%) of these variables. Similarly, nothing can be said about the effect which very low measures (e.g. 5%-10%) of content variables have on achievement and attitude. Activities operationalized by Direct Activity, Content, Content Cross, and Lecture plus Drill never occurred less than 21% of the time. This phenomenon of "restricted ranges" is common to all of the variables and is a factor to be considered when generalizing the results of this study.

Tables 22, 23, and 24 in Appendix B display the mean, standard deviation, and range of all variables for the within grade level analyses. These tables are similar in most respects to Table 8.

Correlation Analysis

A large number of correlation coefficients were calculated in an effort to provide descriptive measures of the extent to which all pairs of variables considered were linearly associated. None of the correlation coefficients were tested for significance because the model underlying the test assumes that any relationship which exists is entirely linear, and such an assumption seemed inconsistent with the emphasis placed on trend analysis in this study.

Question number one regarding the intercorrelations among all variables is answered by the coefficients appearing in Table 9. This matrix, based on the total sample, indicated that many of the independent variables have strong associations with one another. In some cases the intercorrelations are strong enough to suggest that more than one name may have been given to essentially the same variable. For example, 35 of the intercorrelations among predictor variables are greater than .80 and 11 are greater than .90. Pairwise independent variables which were correlated greater than .90 were: I/D Ratio (V_7)-I/(I+D) Ratio (V_8), Restrictive Activity (V_{10})-Big Vicious Circle (V_{18}), Direct Activity (V_{12}) - Teacher Lecture (V_{21}), Teacher Talk (V_{13})-Content (V_{22}), Expansive Activity (V_9) -Reward (V_{29}), Teacher Lecture (V_{21}) - Content (V_{22}), Content (V_{22}) - Content Cross (V_{23}), Teacher Lecture (V_{21}) - Lecture plus Drill (V_{25}), Content (V22) - Lecture plus Drill (V_{25}), Sustained Acceptance (V_{26}) - Sustained Expansive Activity (V_{27}), and Content Cross (V_{23}) - Lecture plus Drill (V_{25}).

Note also that several interaction variables had approximately the same correlations with pre-criterion measures as with post-criterion measures. Examples are: Direct Activity (V_{12}), Student Initiated Response (V_{15}), Small Vicious Circle (V_{17}), i/d Ratio (V_4), Expansive Activity (V_9), and Indirect Activity (V_{11}). Therefore, Table 9 does not reveal information about intrinsic correlations which

TABLE 9

Intercorrelations for all Grades Combined

Variables	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}	V_{14}	V_{15}	V_{16}	V_{17}	V_{18}
V_1	1.00																	
V_2	-.05	1.00																
V_3	.78	.07	1.00															
V_4	.20	.44	.32	1.00														
V_5	.03	.12	.23	.52	1.00													
V_6	.23	.40	.36	.90	.52	1.00												
V_7	.17	.18	.25	.31	.26	.49	1.00											
V_8	.22	.16	.29	.34	.24	.53	.99	1.00										
V_9	.17	.34	.30	.72	.40	.86	.62	.64	1.00									
V_{10}	-.20	-.31	-.31	-.70	-.43	-.83	-.38	-.44	-.57	1.00								
V_{11}	.19	.32	.23	.54	.35	.66	.82	.83	.76	-.49	1.00							
V_{12}	-.20	.09	-.25	.04	-.01	-.15	-.77	-.79	-.27	.14	-.36	1.00						
V_{13}	-.05	.29	-.07	.32	.16	.20	-.40	-.41	.09	-.14	.11	.84	1.00					
V_{14}	.06	-.15	.14	-.15	.04	-.04	.49	.51	-.09	-.12	.09	-.72	-.72	1.00				
V_{15}	.24	-.06	.24	-.05	-.20	.05	.08	.11	.18	.02	-.11	-.40	-.37	-.03	1.00			
V_{16}	.16	-.17	.23	-.16	-.05	-.01	.49	.52	.00	-.11	.04	-.83	-.82	.90	.41	1.00		
V_{17}	-.21	-.21	-.31	-.48	-.26	-.61	-.37	-.42	-.43	.87	-.45	.14	-.10	-.19	.10	-.14	1.00	
V_{18}	-.22	-.27	-.28	-.39	-.36	-.73	-.43	-.49	-.52	.94	-.53	.19	-.09	-.20	.03	-.18	.85	1.00

TABLE 9-continued

Variables	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}	V_{14}	V_{15}	V_{16}	V_{17}	V_{18}
V_{19}	-.19	-.28	-.31	-.51	-.35	-.61	-.36	-.39	-.44	.80	-.50	.00	-.26	-.11	.32	.03	.89	.74
V_{20}	.15	.21	.10	.23	.20	.32	.72	.72	.36	-.28	.88	-.31	.09	.19	-.28	.06	-.33	-.38
V_{21}	-.10	.22	-.11	.34	.17	.21	-.57	-.57	-.02	-.29	-.13	.91	.88	-.65	-.40	-.76	-.23	-.21
V_{22}	-.06	.28	-.07	.42	.24	.32	-.35	-.34	.10	-.38	.15	.81	.91	-.59	-.49	-.75	-.35	-.34
V_{23}	-.06	.30	-.11	.36	.18	.29	-.20	-.20	.12	-.38	.29	.71	.87	-.51	-.51	-.69	-.38	-.39
V_{24}	.10	.12	.04	.03	.05	.10	.59	.58	.14	-.15	.66	-.30	-.01	.31	-.26	.17	-.24	-.33
V_{25}	-.08	.26	-.10	.36	.20	.25	-.39	-.39	.03	-.35	.09	.82	.89	-.56	-.49	-.72	-.32	-.34
V_{26}	.27	.30	.37	.82	.51	.79	.23	.27	.76	-.59	.47	.06	.30	-.25	.07	-.19	-.41	-.47
V_{27}	.23	.34	.35	.83	.53	.81	.30	.33	.81	-.59	.55	.04	.32	-.26	.05	-.21	-.43	-.48
V_{28}	-.00	.10	.02	.20	.26	.21	.35	.33	.37	-.03	.51	-.01	.23	-.09	-.13	-.14	-.15	-.12
V_{29}	.13	.26	.24	.55	.27	.73	.69	.71	.91	-.47	.77	-.40	-.05	.04	.18	.13	-.36	-.47
V_{30}	-.09	-.39	-.25	-.65	-.38	-.72	-.16	-.19	-.49	.80	-.33	-.08	-.30	.17	.07	.18	.69	.60
V_{31}	-.06	.78	.09	.46	.13	.43	.22	.21	.39	-.42	.38	.09	.32	-.12	-.13	-.16	-.37	-.41
V_{32}	.92	.07	.88	.31	.13	.35	.24	.29	.27	-.31	.27	-.22	-.02	.04	.23	.14	-.27	-.31

TABLE 9-continued

Variables	V_{19}	V_{20}	V_{21}	V_{22}	V_{23}	V_{24}	V_{25}	V_{26}	V_{27}	V_{28}	V_{29}	V_{30}	V_{31}	V_{32}
V_{19}	1.00													
V_{20}	-.39	1.00												
V_{21}	-.34	-.17	1.00											
V_{22}	-.47	.14	.95	1.00										
V_{23}	-.48	.34	.85	.96	1.00									
V_{24}	-.23	.85	-.22	.05	.29	1.00								
V_{25}	-.42	.10	.95	.98	.96	.11	1.00							
V_{26}	-.45	.10	.30	.34	.25	-.13	.28	1.00						
V_{27}	-.48	.18	.29	.35	.28	-.07	.28	.98	1.00					
V_{28}	-.17	.47	.00	.15	.24	.40	.13	.13	.28	1.00				
V29	-.34	.44	-.18	-.04	.04	.29	-.08	.51	.56	.28	1.00			
V_{30}	.74	-.11	-.42	-.46	-.38	.14	-.39	-.59	-.58	.11	-.35	1.00		
V_{31}	-.44	.26	.27	.35	.38	.22	.34	.34	.39	.14	-.31	-.45	1.00	
V_{32}	-.26	.19	-.08	-.02	-.02	.14	-.03	.35	.32	.01	.22	-.20	.10	1.00

are independent of pre-criterion measures. A statistic designed to control for nuisance associations is partial correlation.

Partial correlation coefficients were calculated to determine linear associations between independent variables and post-criterion measures which are free of linear associations between independent variables and pre-criterion measures. Table 10 presents these first-order partial correlations along with corresponding zero-order correlations.

The table indicates that when Pre-Achievement was held constant several correlations were substantially reduced in size. The specific associations for which this was true are: Post-Achievement vs. I/(I+D) Ratio, Indirect Activity, Small Vicious Circle, and Rebellion; and Post-Attitude vs. i/d Ratio, i/(i+d) Ratio, Expansive Activity, Indirect Activity, Teacher Talk, Teacher Questions, and Sustained Acceptance. However, most of the correlations were not reduced by the partialling out of pre-criterion measures. Correlations between Post-Achievement and the independent variables of I. Q., i/d Ratio, i/(i+d) Ratio, Expansive Activity, Restrictive Activity, Big Vicious Circle, Sustained Acceptance, and Sustained Expansive Activity remained essentially unchanged or else increased when Pre-Achievement was held constant. Interaction variables whose correlations with Post-Attitude were not reduced by the partialling out of Pre-Achievement were: Restrictive Activity, Small Vicious Circle,

TABLE 10

Zero-Order and First-Order Correlations Between Independent and Dependent Variables

Independent Variables	Dependent Variable			
	Post-Achievement		Post-Attitude	
	Zero Order	First Order (Pre-Achievement held Constant)	Zero Order	First Order (Pre-Attitude held Constant)
V_1 Pre-Achievement	.92	---	-.06	.05
V_2 Pre-Attitude	.07	.30	.78	---
V_3 I.Q.	.88	.66	.09	.06
V_4 i/d Ratio	.31	.33	.46	.21
V_5 Flexibility	.13	.26	.13	.06
V_6 i/(i+d) Ratio	.35	.36	.43	.19
V_7 I/D Ratio	.24	.22	.22	.13
V_8 I/(I+D) Ratio	.29	.23	.21	.14
V_9 Expansive Activity	.27	.29	.39	.22
V_{10} Restrictive Activity	-.31	-.33	-.42	-.31
V_{11} Indirect Activity	.27	.25	.38	.23
V_{12} Direct Activity	-.22	-.09	.09	.03
V_{13} Teacher Talk	-.02	-.07	.32	.16
V_{14} Directed Student Response	.04	-.04	-.12	.00
V_{15} Student Initiated Response	.23	.02	-.13	-.13
V_{16} Student Talk	.14	-.01	-.16	-.05
V_{17} Small Vicious Circle	-.27	-.02	-.37	-.35
V_{18} Big Vicious Circle	-.31	-.28	-.41	-.40
V_{19} Rebellion	-.26	-.22	-.44	-.49
V_{20} Teacher Questions	.19	.13	.26	.24
V_{21} Teacher Lecture	-.08	.03	.27	.57
V_{22} Content	-.02	.09	.35	.65
V_{23} Content Cross	-.02	.09	.38	.70
V_{24} Drill	.14	.01	.22	.23
V_{25} Lecture plus Drill	-.03	.01	.34	.66
V_{26} Sustained Acceptance	.35	.27	.34	.22
V_{27} Sustained Expansive Activity	.32	.28	.39	.36
V_{28} Praise	.01	.03	.14	.23
V_{29} Reward	.22	.25	.31	.38
V_{30} Restrictive Feedback	-.20	.30	-.45	.86

Big Vicious Circle, Rebellion, Teacher Lecture, Content, Content Cross, Lecture plus Drill, Sustained Expansive Activity, Reward, and Restrictive Feedback.

The correlation analyses discussed above provided statistical evidence in support of several potentially important independent-dependent variable associations. The results presented in the next section should help clarify the statistical and educational significance of these correlations.

Correlation analyses for individual grade levels are presented in Tables 25, 26, 27, and 28 of Appendix C.

As indicated previously, most of the analyses carried out in this paper were derived from an analysis of variance model which used independent variable quartiles as sample levels. Hence, correlations between independent variable quartile levels and dependent variable standardized scores were calculated to provide descriptive measures of linearity for the kind of sample levels used in the analysis of variance model. Table 29 in Appendix C contains these quartile vs. T-score correlations for all variables and grade level combinations considered.

Inferential Statistics

Results of analyses which used sample data to estimate measures of various population associations are included in this section. These results relate to specific questions 2-11 of the preceding chapter. Tables based only on the total sample of all three grade levels are presented in this section. The results of individual grade level analyses can be found in Appendices D and E.

Analysis of Variance

Fixed effects, single factor, analyses of variance provided the basic statistics for the determination of significance, trend, and strength of associations needed to answer questions 2-7.

Over-all Significance.--Questions 2 and 3 concern the statistical significance of over-all independent-dependent variable associations. The specific questions are:

(2) Which of the 30 independent variables have statistically significant over-all associations with Post-Achievement?

(3) Which of the 30 independent variables have statistically significant over-all associations with Post-Attitude?

The F ratios displayed in Table 11 answer these questions for the sample considered here. These F ratios indicate that two uncontrollable variables and five interaction variables had statistically significant over-all associations with Post-Achievement.

The uncontrollable variables were Pre-Achievement and I.Q., and, as was expected, F ratios involving these variables were very high in comparison to those involving interaction variables.

The significant interaction variables almost exclusively represented the extremes of expanding or restricting student freedom. These variables were: Expansive Activity, Indirect Activity, Small Vicious Circle, Sustained Acceptance, and Sustained Expansive Activity. Although no

TABLE 11

Analysis of Variance Over-All F Ratios for All Sixty Classes

Independent Variable		Dependent Variable	
		Achievement	Attitude
V_1	Pre-Achievement	39.43**	1.29
V_2	Pre-Attitude	2.36	23.67**
V_3	I. Q.	34.46**	.80
V_4	i/d Ratio	2.15	6.19**
V_5	Flexibility	4.51	1.83
V_6	i/(i+d) Ratio	2.15	6.19**
V_7	I/D Ratio	1.98	.68
V_8	I/(I+D) Ratio	1.98	.68
V_9	Expansive Activity	3.29*	4.09*
V_{10}	Restrictive Activity	1.71	2.47
V_{11}	Indirect Activity	3.26*	2.69
V_{12}	Direct Activity	2.05	.79
V_{13}	Teacher Talk	1.24	2.26
V_{14}	Directed Student Response	.25	2.71
V_{15}	Student Initiated Response	1.16	.39
V_{16}	Student Talk	.92	.46
V_{17}	Small Vicious Circle	3.15*	3.57*
V_{18}	Big Vicious Circle	1.36	2.98*
V_{19}	Rebellion	1.80	4.33**
V_{20}	Teacher Questions	.75	2.13
V_{21}	Teacher Lecture	1.19	1.43
V_{22}	Content	.10	2.55
V_{23}	Content Cross	.18	4.28**
V_{24}	Drill	1.86	.44
V_{25}	Lecture plus Drill	.28	2.96*
V_{26}	Sustained Acceptance	3.37*	2.43
V_{27}	Sustained Expansive Activity	3.61*	3.66*
V_{28}	Praise	.65	1.13
V_{29}	Reward	1.09	3.32*
V_{30}	Restrictive Feedback	2.45	2.89*

* significant at 5% level
** significant at 1% level

cause-effect relationship can be inferred from these F ratios, it is a fact that classes in which teachers encouraged student participation and self expression and largely avoided the giving of criticisms and directions learned more than classes where teachers engaged in contrasting types of behavior. The direction of significant associations can be determined by looking at the correlations on page 84.

In response to question 3, one uncontrollable variable and eleven interaction variables had statistically significant over-all associations with Post-Attitude. Of course, the uncontrollable variable was Pre-Attitude which had a highly significant association with Post-Attitude.

Twice as many interaction variables were associated with Post-Attitude as were with Post-Achievement. Three variables (Expansive Activity, Small Vicious Circle, and Sustained Expansive Activity) were associated with both post-criterion measures. The interaction variables associated only with Post-Attitude were: i/d Ratio, Big Vicious Circle, Rebellion, Content Cross, Lecture plus Drill, Reward, and Restrictive Feedback. Since the i/d Ratio and i/(i+d) Ratio represent exactly the same variable when independent variable quartiles are used, only the i/d Ratio was reported above.

As was true with Post-Achievement, the interaction variables associated with Post-Attitude usually involved the extremes of expansion vs. restriction of student freedom. One exception was Content Cross which had a highly positive association with Post-Attitude.

Trend Analysis. --Questions 4 and 5 relate to the trends of associations.

(4) Which significant over-all associations are linear and which are curvilinear?

(5) Which significant curvilinear associations are quadratic and which are cubic?

Table 12 contains information relevant to these questions. Significance tests for linear and curvilinear regressions were made only for associations which had significant over-all F ratios in Table 11.

The F ratios in Table 12 suggest that all significant associations were essentially linear. Although Pre-Achievement and I. Q. did have statistically significant curvilinear associations with Post-Achievement, the corresponding linear associations were much more significant. For every other significant over-all association the linear trend was statistically significant while the curvilinear trend was not.

The fact that all significant associations were essentially linear suggests that regression analysis, which assumes a linear model, should give a fairly accurate picture of the interactive contributions of predictor variables.

Information pertaining to questions 2, 3, and 4 for the separate grade levels appears in Tables 30, 31, and 32 of Appendix D.

Only over-all associations which were significant at the .05 level and for which curvilinear regression accounted for more of the dependent variable variance than did linear regression were investigated for quadratic and cubic trend. Since none of the associations reported above fit this criterion, they were not investigated further for these

TABLE 12

F Ratios for Linear and Curvilinear Trends
Based on All Sixty Classes

Independent Variable		Dependent Variable	Regression	
			Linear	Curvilinear
V_1	Pre-Achievement	Achievement	111.62**	3.33*
V_2	Pre-Attitude	Attitude	65.93**	2.54
V_3	I.Q.	Achievement	90.03**	6.67**
V_4	i/d Ratio	Attitude	16.95**	.81
V_6	i/(i+d) Ratio	Attitude	16.95**	.81
V_9	Expansive Activity	Achievement	5.39*	2.24
V_9	Expansive Activity	Attitude	11.15**	.55
V_{11}	Indirect Activity	Achievement	4.15*	2.82
V_{17}	Small Vicious Circle	Achievement	8.51**	.46
V_{17}	Small Vicious Circle	Attitude	9.79**	.47
V_{18}	Big Vicious Circle	Attitude	6.38*	1.29
V_{19}	Rebellion	Attitude	12.22*	.39
V_{23}	Content Cross	Attitude	11.41**	.71
V_{25}	Lecture plus Drill	Attitude	7.46**	.71
V_{26}	Sustained Acceptance	Achievement	9.11**	.49
V_{27}	Sustained Expansive Activity	Achievement	9.21**	.81
V_{27}	Sustained Expansive Activity	Attitude	9.98**	.50
V_{29}	Reward	Attitude	6.73*	1.62
V_{30}	Restrictive Feedback	Achievement	7.98**	2.89*

* significant at 5% level
** significant at 1% level

higher-order trends. However, eight significant associations based on within grade level samples were essentially curvilinear and thus were tested for quadratic and cubic trends. Seven of the curvilinear associations proved to be quadratic and one proved to be cubic. The results of these within grade higher-order trend analyses appear in Table 33 of Appendix D. Also, figures 6 through 13 in Appendix D display scatter plots for each statistically significant quadratic and cubic trend.

Strength Analysis. --Questions 6 and 7 are concerned with the strengths of all independent - dependent variable associations.

> (6) What are the proportions of variance due to linear, curvilinear, and over-all regression with achievement which are accounted for by each of the 30 independent variables?
>
> (7) What are the proportions of variance due to linear, curvilinear, and over-all regression with attitudes which are accounted for by each of the 30 independent variables?

Population estimates of answers to these questions are contained in Table 13.

Three associations between uncontrollable and post-criterion variables were quite strong. Quartile levels of Pre-Achievement and I.Q. accounted respectively for an estimated 66% and 63% of the variance in Post-Achievement. And Pre-Attitude accounted for over half the variance in Post-Attitude. Although no association involving interaction variables was as strong, several interaction variables did account for over 10% of the variance in post-criterion measures. These variables were: Expansive Activity (V_9), Sustained Acceptance

TABLE 13

Proportion of Variance in Dependent Variables Accounted for by Independent Variables in All Sixty Classes

Independent Variable:	Dependent Variable: Post Achievement			Dependent Variable: Post Attitude		
	Linear Regression	Curvilin Regression	Over all ω^2	Linear Regression	Curvilin Regression	Over all ω^2
V_1	.63	.03	.66	.00	.01	.01
V_2	.00	.06	.06	.51	.02	.53
V_3	.56	.07	.63	.00	.00	.00
V_4	.05	.00	.05	.21	.00	.21
V_5	.00	.00	.00	.04	.00	.04
V_6	.05	.00	.05	.21	.00	.21
V_7	.01	.01	.02	.00	.00	.00
V_8	.01	.01	.02	.00	.00	.00
V_9	.07	.03	.11	.13	.00	.13
V_{10}	.03	.00	.03	.07	.00	.07
V_{11}	.05	.05	.10	.08	.00	.08
V_{12}	.03	.02	.05	.00	.00	.00
V_{13}	.00	.01	.01	.06	.00	.06
V_{14}	.00	.00	.00	.01	.07	.08
V_{15}	.01	.00	.01	.00	.00	.00
V_{16}	.00	.00	.00	.00	.00	.00
V_{17}	.10	.00	.10	.11	.00	.11
V_{18}	.02	.00	.02	.08	.01	.09
V_{19}	.04	.00	.04	.14	.00	.14
V_{20}	.00	.00	.00	.05	.00	.05
V_{21}	.00	.01	.01	.02	.00	.02
V_{22}	.00	.00	.00	.07	.00	.07
V_{23}	.00	.00	.00	.14	.00	.14
V_{24}	.00	.04	.04	.00	.00	.00
V_{25}	.00	.00	.00	.09	.00	.09
V_{26}	.11	.00	.11	.07	.00	.07
V_{27}	.12	.00	.12	.12	.00	.12
V_{28}	.00	.00	.00	.01	.00	.01
V_{29}	.00	.00	.00	.09	.02	.11
V_{30}	.06	.01	.07	.09	.00	.09

(V_{26}), and Sustained Expansive Activity (V_{27}) for Post-Achievement; and i/d Ratio (V_4), Expansive Activity (V_9), Small Vicious Circle (V_{17}), Rebellion (V_{19}), Content Cross (V_{23}), Sustained Expansive Activity (V_{27}), and Reward (V_{29}) for Post-Attitude.

It was mentioned earlier that important curvilinear associations can go unnoticed in multiple linear regression equations. The ratio of linear strengths in Table 13 to corresponding over-all strengths gives some indication of the extent to which regression equations represent all of the predictive power of independent variables. For each over-all strength of association greater than 10% in Table 13 the ratio of linear strength to over-all strength was greater than .63.

Estimated strenths of association for linear, curvilinear, and over-all regressions based on the individual grade levels are presented in Tables 34, 35, and 36 of Appendix D. These estimated strengths of association are not always consistent with the regression analysis described below because the ω^2 values are based on predictor variable quartile levels.

Regression Analysis

This section relates the results of stepwise regression procedures which used standardized T scores to predict dependent variable scores.

Standardized T scores as measures of predictor variables were used for two reasons. One reason was the fact that T scores yield the same multiple correlation coefficient and coefficient of determination as do corresponding raw scores. Secondly, the β coefficients of regression equations based on predictor variable standardized scores represent standard partial regression coefficients. In general standard partial regression coefficients are better indicators of the relative predictive contributions of independent variables than are regular partial regression coefficients associated with independent variable raw scores.

Table 14 presents the results of stepwise regression analyses pertaining to questions 8 and 9. At each step in the table the variable is added which, in combination with variables generated by previous steps, offers the best prediction. Also, at each step the relative predictive weights of independent variables are represented in the form of standard partial regression coefficients.

Questions 8 and 9 are:

(8) What combination of independent variables is generated as the best predictor of achievement in the multiple linear regression equation?

(9) What is the proportion of variance due to linear regression with achievement which is accounted for by the best predictive combination of variables?

From Table 14 it can be seen that Pre-Achievement accounted for 85% of the variance in Post-Achievement at the first step of the stepwise regression analysis, and I. Q. increased this proportion of variance accounted for by another 7% at the second step. However, the inclusion of six interaction variables with Pre-Achievement and I. Q. in the prediction of Post-Achievement offered only a 2% increase in predictive power at the eighth step. The multiple linear regression equation generated by the eighth step of the analysis is

$$Y' = .56V_1 + .41V_3 + .16V_6 - .10V_9 - .10V_{13} - .17V_{14} + .13V_{24} - .04V_{28} + 6.83$$

TABLE 14

Step by Step Results of Regression Analyses
Using Standardized T-Scores to Predict Post-Achievement
for all Sixty Classes

Independent Variable	Step	Standard Partial Regression Coefficients	R	R^2
Pre-Achievement (V_1)	1	.92 (V_1)	.92	.85
Pre-Achievement (V_1), I.Q. (V_3)	2	.61 (V_1),.40(V_3)	.96	.92
Pre-Achievement (V_1), I.Q.(V_3),i/(i+d) Ratio (V_6)	3	.61(V_1),.36(V_3), .08(V_6)	.96	.92
Pre-Achievement (V_1), I.Q. (V_3), i/(i+d) Ratio(V_6),Drill(V_{24})	4	.60(V_1),.37(V_3), .07(V_6),.06(V_{24})	.96	.92
Pre-Achievement(V_1), I.Q. (V_3), i/(i+d) Ratio(V_6), Directed Student Response (V_{14}), Drill (V_{24})	5	.59(V_1),.40(V_3), .06(V_6),-.07 (V_{14}), .08(V_{24})	.96	.93
Pre-Achievement(V_1), I.Q. (V_3), i/(i+d) Ratio(V_6),Directed Student Response (V_{14}), Drill (V_{24}), Praise (V_{28})	6	.58(V_1),.40(V_3), .07(V_6),-.09(V_{14}), .11(V_{24}),-.07(V_{28})	.97	.93
Pre-Achievement(V_1), I.Q. (V_3),i/(i+d) Ratio (V_6), Teacher Talk (V_{13}), Directed Student Response (V_{14}), Drill(V_{24}), Praise (V_{28})	7	.57(V_1),.41(V_3), .07(V_6),-.06 (V_{13}),-.14 (V_{14}), .13 (V_{24}), -.07 (V_{28})	.97	.93
Pre-Achievement(V_1), I.Q. (V_3),i/(i+d) Ratio (V_6), Expansive Activity (V_9), Teacher Talk (V_{13}), Directed Student Response (V_{14}), Drill (V_{24}), Praise (V_{28})	8	.56(V_1),.41(V_3), .16(V_6),-.10 (V_9),-.10(V_{13}), -.16(V_{14}), .13 (V_{24}), .04(V_{28})	.97	.94

This equation suggests that Post-Achievement increased .56 units as Pre-Achievement increased 1 unit, .41 units as I. Q. increased 1 unit, .16 units as i/(i+d) Ratio increased 1 unit, etc.

At first glance the results of Table 14 might appear to be inconsistent with Table 10 which showed several correlations between interaction variables and Post-Achievement to be unaffected by the partialling out of Pre-Achievement. But only Pre-Achievement was held constant in the correlation analysis while both Pre-Achievement and I. Q. were partialled out in the regression analysis.

In response to question 8 the combination of eight variables which was generated as the best predictor of achievement is: Pre-Achievement (V_1), I. Q. (V_3), i/(i+d) Ratio (V_6), Expansive Activity (V_9), Teacher Talk (V_{13}), Directed Student Response (V_{14}), Drill (V_{24}), and Praise (V_{28}). The proportion of variance due to linear regression accounted for by this best predictive combination of eight variables is 94%. This unusually high proportion of variance accounted for was due in part to the fact that observations consisted of class means rather than individual student scores. Some problems of interpretation created by the necessity of using class means were discussed under the limitations section of the preceding chapter.

Table 15 contains statistical results related to questions 10 and 11. These questions are:

(10) What combination of independent variables is generated as the best predictor of attitudes in the multiple linear regression equation?

TABLE 15

Step by Step Results of Regression Analyses
Using Standardized T-Scores to Predict Post-Attitude
for all Sixty Classes

Independent Variable	Step	Standard Partial Regression Coefficients	R	R^2
Pre-Attitude (V_2)	1	.78(V_2)	.78	.61
Pre-Attitude (V_2), Rebellion (V_{19})	2	.72(V_1), -.23(V_{19})	.81	.66
Pre-Attitude (V_2), Rebellion (V_{19}), Drill (V_{24})	3	.71(V_2), -.22(V_{19}) .80(V_{24})	.82	.67
Pre-Attitude (V_2), Rebellion (V_{19}), Drill (V_{24}), Teacher Questions (V_{20})	4	.72(V_2),-.26(V_{19}) -.20(V_{20}).24(V_{24})	.82	.68
Pre-Attitude (V_2), Rebellion (V_{19}), Teacher Questions(V_{20}) Drill(V_{24}), Sustained Expansive Activity(V_{27})	5	.70(V_2),-.21(V_{19}), -.26(V_{20}).31(V_{24}), .12(V_{27})	.83	.69
Pre-Achievement(V_1), Pre-Attitude(V_2), Rebellion(V_{19}), Teacher Questions(V_{20}),Drill(V_{24}), Sustained Expansive Activity(V_{27})	6	-.098(V_1),.68(V_2), -.22(V_{19}),-.26(V_{20}), .32(V_{20}),.15(V_{27})	.83	.70
Pre-Achievement(V_1), Pre-Attitude(V_2), Flexibility(V_5), Rebellion (V_{19}), Teacher Questions(V_{20}), Drill(V_{24}), Sustained Expansive Activity(V_{27})	7	-.11(V_1),.66(V_2), -.10(V_5),-.23(V_{19}) -.24(V_{20}),.32(V_{24}) .20(V_{27})	.84	.70
Pre-Achievement(V_1), Pre-Attitude(V_2),Flexibility(V_5),Rebellion (V_{19}),Teacher Questions(V_{20}),Drill(V_{24}), Sustained Acceptance (V_{26}),Sustained Expansive Activity(V_{27})	8	-.09(V_1),.66(V_2), -.099(V_5),-.24(V_{19}) -.28(V_{20}),.33(V_{24}), -.34(V_{26}),.54(V_{27})	.84	.71

(11) What is the proportion of variance due to linear regression with attitudes which is accounted for by the best predictive combination of variables?

The interaction variables seemed to have more important associations with attitudes than they did with academic achievement. Although Pre-Attitudes accounted for most of the variance (61%) in Post-Attitude scores, interaction variables plus Pre-Attitude were able to account for an additional 10% of the variance. At the second step of the regression analysis Rebellion alone increased the proportion of variance accounted for by 5%, and the addition of each new predictor variable generally accounted for another 1% of the variance up to the eighth step.

In response to questions 10 and 11 the best combination of eight variables in the prediction of Post-Attitude is: Pre-Achievement (V_1), Pre-Attitude (V_2), Flexibility (V_5), Rebellion (V_{19}), Teacher Questions (V_{20}), Drill (V_{24}), Sustained Acceptance (V_{26}), and Sustained Expansive Activity (V_{27}); and the proportion of variance in Post-Attitude scores accounted for by this combination is 71%.

Results of regression analyses for individual grade levels appear in Table 32 of Appendix E.

Regression analyses involving predictor variable quartile levels were used in the development of the computer simulation program. Some results of these analyses are contained in Table 38 of Appendix E.

Summary of Results

What follows in this section is an attempt to summarize the major findings of the study. The discussion focuses primarily upon the combined grade level analyses although some attention is given to significant aspects of the individual grade level analyses previously reported in the appendices.

Even though an observation in this study consisted of a single score per class instead of the conventional score for each subject, the results obtained were, with a few exceptions, in conformance with the general thrust of the research reviewed in Chapter II. That is, intellective factors were much better predictors of academic achievement than were non-intellective factors, non-intellective factors had stronger associations with student attitudes than did intellective factors, student attitudes were fairly independent of academic achievement, and intellective plus non-intellective factors offered little improvement in the prediction of academic achievement over intellective factors alone.

Findings related to higher than chance pairwise associations are summarized in Tables 16 and 17. These tables show the significant over-all F-ratios and corresponding trend analyses for each grade level separately and for all three grade levels combined.

As suggested by these summary tables the only consistently strong associations were those between V_1 and V_3 and Post-Achievement and between V_2 and Post-Attitude. In other words, a kind of

TABLE 16

Significant Over All F Ratios for Post Achievement and Corresponding Trend Analyses

Independent Variable	Grade Level	Type of Regression				
		Lin Reg	Curv Lin	(Quad)	(Cub)	Over-all
V_1	6	66.22**	1.28			22.92**
V_3	6	34.19**	2.24			12.89**
V_4	6	8.06**	2.07			4.07*
V_6	6	8.06**	2.07			4.07*
V_{17}	6	7.42*	4.91	8.8**	0.8	5.75**
V_{26}	6	9.71**	3.91*			5.85**
V_{27}	6	7.26*	3.63*			4.84**
V_{30}	6	5.41*	4.57*	6.3*	2.7	4.85**
V_1	7	20.18**	1.71			7.87**
V_3	7	19.24**	2.85			8.31**
V_{10}	7	4.19	3.29	7.1*	0.0	3.59*
V_{17}	7	11.07*	.44			3.98*
V_{18}	7	5.92*	2.15			3.41*
V_{30}	7	4.52	3.33	7.2*	0.0	3.73*
V_1	8	24.22**	.95			8.71**
V_3	8	61.79**	7.17**			25.37**
V_1	all	111.62**	3.33*			39.43**
V_3	all	90.03**	6.67**			34.46**
V_9	all	5.39*	2.24			3.29*
V_{11}	all	4.15*	2.82			3.26*
V_{17}	all	8.51**	.46			3.15*
V_{26}	all	9.11**	.49			3.37*
V_{27}	all	9.21**	.81			3.61*

* sig at 5% level
** sig at 1% level

TABLE 17

Significant Over All F Ratios for Post Attitude and Corresponding Trend Analyses

Independent Variable	Grade Level	Type of Regression				
		Lin Reg	Curv	(Quad)	(Cub)	Over-all
V_2	6	22.24**	1.29			8.27**
V_{26}	6	6.66**	1.98			3.54*
V_{28}	6	9.08**	1.31			3.90*
V_2	7	7.64*	4.68*	8.1*	2.3	5.67**
V_9	7	1.59	4.48*			3.52*
V_{19}	7	3.73	3.71	0.0	7.5*	3.72*
V_2	8	18.77**	.45			6.56**
V_9	8	7.79*	5.89*	11.8**	0.0	6.52**
V_{10}	8	7.13*	3.55			4.74*
V_{15}	8	10.05**	1.26			4.19*
V_{25}	8	5.04*	2.51			3.35*
V_{29}	8	7.48*	5.81*	11.6**	0.0	6.37**
V_{30}	8	.16	8.66**			5.83**
V_2	all	65.93**	2.54			23.67**
V_4	all	16.95**	.81			6.19**
V_6	all	16.95**	.81			6.19**
V_9	all	11.15**	.55			4.09*
V_{17}	all	9.79**	.47			3.57*
V_{18}	all	6.38*	1.29			2.98*
V_{19}	all	12.22*	.39			4.33**
V_{23}	all	11.41**	.71			4.28**
V_{25}	all	7.46**	.71			2.96*
V_{27}	all	9.98**	.50			3.66*
V_{29}	all	6.73*	1.62			3.32*
V_{30}	all	7.98**	.35			2.89*

* sig at 5% level, ** sig at 1% leve

"capacity to learn" (Pre-Achievement and I. Q.) which a class brought to the learning situation was the most important determiner of how well that class did on the Post-Achievement test, and Pre-Attitude scores were the best single predictor of Post-Attitude scores.

Although the associations between ability variables and learning were very strong, Table 16 reveals some statistically significant associations between the controllable or verbal interaction variables and student achievement. Associations which were statistically significant varied somewhat depending on the particular grade level considered. But even when the total sample of all sixty classes is used there are a few verbal interaction variables which account for a substantial amount of variance in the Post-Achievement scores. For example, in the sample consisting of the combined sixth, seventh, and eighth grade classes, V_9(Expansive Activity), V_{11} (Indirect Activity), V_{17}(Small Vicious Circle), V_{26}(Sustained Acceptance), and V_{27} (Sustained Expansive Activity) all had statistically significant associations with academic achievement and, individually, accounted for an estimated 10% or more (Table 13) of the variance in the achievement scores. In light of the fact that eighth grade geometry classes, seventh grade social studies classes, and general sixth grade classes represent very diverse teaching-learning situations, the above associations between the verbal influence patterns of teachers and the mean achievement for groups of students merit further investigation.

As was expected, the interaction variables had more and stronger associations with the Post-Attitude scores than with the Post-Achievement scores. Tables 13 and 17 indicate that for the three grade levels combined the verbal interaction variables of V_6 (i/(i+d) Ratio), V_9 (Expansive Activity), V_{17} (Small Vicious Circle), V_{19} (Rebellion), V_{23} (Content Cross), V_{27} (Sustained Expansive Activity), and V_{29} (Reward) each accounted for an estimated 10% to 21% of the variance in Post-Attitude scores and also had statistically significant over-all associations with student attitudes.

When analyses were based upon the total sample all of the significant associations proved to be essentially linear. However, as indicated in Tables 16 and 17, some of the within grade level associations were curvilinear. All of the significant curvilinear regressions were quadratic with the exception of one which was cubic.

The research implications of Chapter II, which suggested that student attitudes and academic achievements can be fairly independent, were supported in this study. In no case was there a significant association between ability or achievement and attitudinal measures. The correlation coefficients presented in Tables 9, 25, 26, and 27 represent some negative associations for ability vs. attitude variables.

The intercorrelation matrices point out the fact that many of the independent or predictor variables investigated were highly interrelated. Consequently, it is uncertain how many (if any) of the significant relationships involving interaction variables are independent of each other or independent of corresponding associations involving uncontrollable variables. The use of regression analyses enables one to look at combinations of variables which offer independent contributions to the prediction of outcome scores. Table 18 contains unbiased estimates of multiple correlation coefficients and coefficients of determination for some selected stepwise regression analyses. McNemar's correction for shrinkage formula, stated in Chapter III, was used to calculate the unbiased estimates.

Under the sub-heading for independent variables in Table 18, the numbers to the left of the colon represent the variables which were considered in the stepwise regression procedure, and the numbers to the right of the colon indicate which variables were generated as best predictors for the step specified. Note that the numbers 4-30 refer to the interaction variables, and 1-30 to all 30 predictor variables.

Table 18 indicates that interaction variables alone were able to account for an estimated 20% of the variance in achievement and 28% of the variance in attitudes for all grade levels combined. However, the extent to which these predictions are independent of concomitant associations between interaction variables and uncontrollable predictors is debatable. More will be said about this problem of interpretation in the next sub-section.

TABLE 18

Unbiased Estimates of the Multiple Correlation Coefficient (R') and Coefficient of Determination $(R')^2$ for Selected Stepwise Regression Analyses using Standardized T-Scores to Predict Dependent Variable Standardized T- Scores

Independent Variables Considered followed by those Generated as best Predictors	Dependent Variable	Grade Level	Step	R'	$(R')^2$
1-3: 1,2	Achievement	6	2	.99	.98
4-30: 5,13,15,17,23	Achievement	6	5	.67	.45
1-30. 1,2,4,6,23,28	Achievement	6	6	.99	.98
1-3: 2	Attitude	6	1	.86	.74
4-30: 4,5,13,15,21	Attitude	6	5	.63	.38
1-30: 2,4,5,9.15,28	Attitude	6	6	.90	.81
1-3: 1,3	Achievement	7	2	.90	.81
4-30. 4,14,15,17,30	Achievement	7	5	.90	.81
1-30. 1,2,3,4,14,17	Achievement	7	6	.95	.91
1-3: 2	Attitude	7	1	.66	.44
4-30: 5,10,18,19,30	Attitude	7	5	.77	.59
1-30: 2,5,7,17,19,28	Attitude	7	6	.79	.63
1-3: 1,3	Achievement	8	2	.97	.94
4-30: 5,10,14,18,26	Achievement	8	5	.70	.49
1-30: 1,3,15,17,19,20	Achievement	8	6	.99	.98
1-3: 2	Attitude	8	1	.71	.51
4-30: 6,15,17,19,24	Attitude	8	5	.74	.55
1-30: 1,2,18,19,24,28	Attitude	8	6	.89	.79
1-3: 1,3	Achievement	all	2	.95	.91
4-30: 9,12,13,15,26	Achievement	all	5	.45	.20
1-30: 1,3,6,9,13,14 24,28	Achievement	all	8	.96	.93
1-3: 2	Attitude	all	1	.78	.61
4-30: 4,5,13,19,24	Attitude	all	5	.53	.28
1-30: 1,2,5,19,20,24 26,27	Attitude	all	8	.81	.66

When standardized T-scores were used in the regression equations the power of ability variables in predicting achievement was almost overwhelming. Table 18 shows that unbiased estimates of multiple correlation coefficients for regression equations where measures of I.Q. and Pre-Achievement were used to predict Post-Achievement scores were at least .90 for all grade level combinations. Hence, there was little room for predictive improvement with the addition of interaction variables to the equations. However, regression equations using five to seven interaction variables plus Pre-Attitude were able to account for an average of about 15% more of the variance in Post-Attitude scores than was Pre-Attitude alone.

Interpretations

Since results of statistical analyses can be quite ambiguous, several different interpretations could be given to the findings reported above. The subjective interpretations of the writer constitute the remainder of this chapter.

The study differs from most in that observations consist of sample means instead of individual scores. As empirically demonstrated in Table 7 of the preceding chapter, the necessity of using sample means resulted in correlation coefficients which were much higher than corresponding correlations for individuals. Therefore, the generalizability of this study applies only to sample mean considerations, and inferences involving individual students are unjustified.

As was stated above, some of the major objectives of this study were to measure the significance, strength, and trend of a large number of classroom relationships, and no adaptation was made in the research design to statistically control for concomitant variations among all of the relationships investigated. Therefore, the nature of the cause-effect associations which might be inferred from the above results is not entirely clear.

Note that those variables which were generated as best predictors in the multiple linear regression equations were not always the same as those which had significant pairwise associations with dependent variables. When the combination of interaction variables plus ability variables was used to predict Post-Achievement some interaction variables which were not significant in Table 11 were included in the stepwise regression equations before those interaction variables which were significant.

The phenomenon discussed in the above paragraph suggests that some of the significant associations between interaction variables and Post-Achievement may have been due to strong associations between ability and interaction variables rather than between interaction variables and Post-Achievement per se. As an example consider the following. Associations between I. Q. and Post-Achievement were always significant, and associations between Sustained Acceptance and Post-Achievement were generally significant. But Sustained Acceptance had higher correlations with I. Q. than with Post-Achievement. So, it is not certain whether or not increased acceptance of student ideas will necessarily produce increased student achievement. It could be that bright children initiate more ideas than do intellectually slow children and thus force high class scores on the sustained acceptance variable.

In summary, several significant and strong pairwise associations have been discovered by the research described in this project, but an understanding of their cause-effect nature requires further research.

At this time the writer wishes to clarify his interpretations of the regression analyses. An argument could be made for the contention that combinations of only interaction variables account for very large amounts of variance in student achievement. In one sense such a contention is supported by Table 18 which lists unbiased estimates for coefficients of determination as high as .78 for regression equations which use only interaction variables to predict achievement. However, these high coefficients of determination do not mean that interaction variables alone will accurately predict achievement irrespective of the ability level of the class. It is the opinion of this writer that the principal reason why combinations of interaction variables had such strong associations with Post-Achievement was due to the concomitant associations which they had with Pre-Achievement and I. Q.

A more meaningful way of looking at the regression analyses is to determine increases in predictive power which ability variables plus interaction variables offer over ability variables alone. This increase in the unbiased estimate of the proportion of variance accounted for by linear regression was .05 on the average for all four grade level combinations. The fact that interaction variables were able to increase the power of ability variables in the prediction of student achievement by about 5% seems to be of some importance.

The results reported in this chapter might have some immediate application to classroom instruction. However, the educational significance of the results is viewed here as relating primarily to implications for further research, and these implications are discussed in the next chapter.

Simulation Program

Much of the rationale underlying the development of the computer simulation program was discussed in Chapter III. The development was based on 29 sixth grade elementary, 15 seventh grade social studies, and 16 eighth grade mathematics classes. The purpose of the program is to generate data which are similar to empirical data, to print out summary statistics for the simulated data, and to make statistical comparisons between specified simulated distributions. Some possible uses of the program are:

(a.) to simulate data associated with various manipulations of classroom variables;

(b.) to study the effect which various independent variable manipulations have on simulated class achievement and attitude scores;

(c.) to generate hypotheses for situations where relation of simulated data to real data is unknown;

(d.) to generate data for instructional purposes.

A description of the simulation program, directions for its use, and samples of output constitute the remainder of this chapter.

Description

The input to the simulation program consists of levels on each of ten classroom variables. The levels which the user may specify must be either all quartiles or else all standardized T-scores for a given set of simulated scores.

The decision regarding which type of input measure to use depends upon one's familiarity with the nature of the relationships among interaction variables. A novice would probably use quartile levels since practically any combination of predictor variable quartile levels could realistically occur. However, standardized T-scores of 80 on i/(i+d) Ratio and of 30 on Sustained Acceptance would be virtually impossible in the real world. Hence, only those familiar with the interaction matrix could knowledgeably specify standardized T-scores for interaction variables. The simulation is much more accurate for inputs of standardized T-scores than for quartile levels.

The ten variables considered in the model are: V_1 (Pre-Achievement), V_2 (Pre-Attitude), V_3 (I.Q.), V_6 (i/(i+d) Ratio), V_{19} (Rebellion), V_{22} (Content), V_{24} (Drill), V_{26} (Sustained Acceptance), V_{28} (Praise), and V_{30} (Restrictive Feedback).

The reasons for choosing these ten variables were based upon three main criteria. One consideration was the consistency with which the variables were associated with either Post-Achievement or Post-Attitude or both, a second was the degree of independence which the variables had with each other, and a third was the theoretical significance of the variables as judged by their relation to other relevant research studies. Most of the variables selected for use in the model ranked high on only one or two of the three criteria.

The output of the simulation program occurs in two phases. The first consists of distributions of thirty probabilistic class scores for both Post-Achievement and Post-Attitude, the means and standard deviations of the two distributions, and 95% confidence intervals and percentile ranks for the two means. The percentile ranks of the means are based upon the Post-Achievement and Post-Attitude scores for sixty classes considered in this study. Specifically, the percentile rank for Mj is figured by dividing the number of scores in the sample of sixty which are less than Mj plus one-half the number of scores equal to Mj by sixty and then multiplying by 100. The second cycle in the output prints out t-ratios for comparisons of differences between the means of the simulated distributions.

Basically, the model functions as described below. The user specifies a level for each of the ten classroom variables. The simulation program then substitutes these levels for values of independent variables in appropriate multiple linear regression equations. The equations in turn generate best guesses in the form of standardized T-scores for class achievement and attitude for classes having the specified levels on each of the independent variables. The specific equations used are:

(1) $$\text{Achievement} = -4.76X_1 - .48X_2 - 3.09X_3 + 1.66X_4 + .07X_5 + .46X_6 - .66X_7 - .90X_8 - .88X_9 + 2.06X_{10} + 66.31$$

(2) $$\text{Attitude} = .84X_1 - 5.31X_2 - .80X_3 - 4.40X_4 + 2.26X_5 - .68X_6 + .15X_7 - 2.25X_8 + .28X_9 - 2.53X_{10} + 69.82$$

(3) $$\text{Achievement} = .61X_1 + .03X_2 + .40X_3 + .06X_4 + .13X_5 + .04X_6 + .11X_7 - .01X_8 - .03X_9 - .09X_{10} - 11.88$$

(4) $$\text{Attitude} = .16X_1 + .68X_2 + .08X_3 - .07X_4 - .16X_5 + .04X_6 + .14X_7 + .12X_8 - .02X_9 - .04X_{10} + 19.62$$

where X_1 = Pre-Achievement, X_2 = Pre-Attitude, X_3=I.Q., X_4 = ($i/(i+d)$ Ratio), X_5 = Rebellion, X_6 = Content, X_7 = Drill, X_8= Sustained Acceptance, X_9 = Praise and X_{10} = Restrictive Feedback. The coefficients in the four equations were obtained from regression analyses and represent the relative predictive contributions of each of the ten variables. Equations (1) and (2) are used when the input consists of quartile levels, and equations (3) and (4) become operative in the model when standardized T-scores are used for predictor variable levels. Associated with each equation is a standard error for the predicted score. The standard errors for equations (1) through (4) are 5.20, 6.60, 2.84, and 6.24 respectively.

After predicted scores and corresponding standard errors of prediction are ascertained the program generates the probabilistic distributions by selecting numbers at random from a population which has a mean equal to the predicted score generated by the regression equations and a standard deviation equal to the standard error of prediction. The program then generates the simulated distributions by printing out thirty of these probabilistic scores for both Post-Achievement and Post-Attitude. As indicated above, summary tables of descriptive statistics also accompany each simulated distribution. If the user wishes to look at simulated distributions for more than one set of input levels, then the model will print out t-ratios for statistical comparisons among all combinations of simulated distributions. So, one could use the program to find out which combinations of input levels result in significantly different class-achievement and attitude scores for the type of composite sample used in the development of the regression equations. When one is interested in samples which are quite different from the one used here, then a useful function of the model might be to generate rather than test hypotheses.

The pairwise comparisons among distributions can be made for no more than four distributions (six comparisons) simultaneously. However, by simply repeating the cycle one can compare any number of simulated distributions with just one approach to the computer.

The simulation program was written in the MAD language for use on the IBM 360 Mod 65 data processing system at The University of Michigan Computing Center and is presented in its entirety in Table 19.

Table 19
Interaction Analysis Simulated Data Program

```
INTEGER I, L, H, S

DIMENSION C(90), MC(90), MT(90), SEMC(90), SEMT(90), TC(10*1

10), TT, (10*10), Q(90), ST(90), SDC(90), SDT(90), T90

VECTOR VALUES EC(1)= 22., 23., 24., 31., 33., 38., 39., 39., 40., 4

11., 43., 44., 45., 45., 46., 47., 47., 48., 48., 48., 48., 49., 49., 49., 51

1., 51., 51., 52., 52., 52., 52., 52., 53., 53., 53., 54., 54., 54., 55., 55.

1, 55., 56., 57., 57., 57., 57., 58., 58., 59., 59., 60., 60., 60., 62., 63.,

163., 64., 65., 66.

VECTOR VALUES ET(1)=31., 32., 33., 33., 34., 35., 36., 37., 38., 3

19., 41., 41., 41., 42., 42., 43., 43., 44., 44., 45., 46., 47., 47., 48

1., 48., 49., 52., 52., 53., 53., 53., 53., 53., 53., 54., 55., 56., 56., 57.

1, 57., 58., 59., 59., 59., 60., 60., 60., 61., 61., 61., 62., 63., 64.,

164., 64., 64., 67.

RNO=O

L=O

START READ FORMAT IN, S, Q(1)... Q(10), ST(1)...ST(10)

VECTOR VALUES IN=$11, 10F1. 0, 10F2. 0*$

SMC=O

SMT=O

SMCSQ=O

SMTSQ=O

WHENEVER S  .G.  O, TRANSFER TO L9

L=L+1
```

```
WHENEVER Q(1) .E. O, TRANSFER TO L1
PC=-4. 76*Q(1)-. 48*Q(2)-3. 09*Q(3)+1. 66*Q(4)+. 07*Q(5)+. 46*Q(6)-
1. 66*Q(7)-. 90*Q(8)-. 88*Q(9)+2. 06*Q(10)+66. 31
PT=. 84*Q(1)-5. 31*Q(2)-. 80*Q(3)-4. 40*Q(4)+2. 26*Q(5)-. 68*Q(6)+.
115*Q(7)+2. 25*Q(8)+. 28*Q(9)-2. 53*Q(10)+69. 83
SEC=5. 20
SET=6. 60
TRANSFER TO L2
L1     PC=. 61*ST(1)+. 03*ST(2)+. 40*ST(3)+. 06*ST(4)+. 13*ST(5)+. 04*ST(6
        1)+. 11*ST(7)-. 01*ST(8)-. 03*ST(9)-. 09*ST(10)-11. 88
       PT=-. 16*ST(1)+. 68*ST(2)+. 08*ST(3)-. 07*ST(4)-. 16*ST(5)+. 04*ST(
       16)-.14*ST(7)+. 12*ST(8)-. 02*ST(9)-. 04*ST(10)+19. 62
       SEC=2. 84
       SET=6. 24
L2     THROUGH L3, FOR I=1,1,I.G. 30
       C(I)=RANDND.(PC,SEC,RND)
       T(I)=RANDND.(PT,SET,RND)
       SMC=SMC+C(I)
       SMT=SMT+T(I)
       SMCSQ=SMCSQ+C(I).P.2
L3     SMTSQ=SMTSQ+T(I).P.2
       MC=SMC/30
       MT=SMT/30
       SDC=SQRT (SMCSQ/30-MC.P.2)
```

```
     SDT=SQRT.(SMTSQ/30-MT.P.2)
     LLC=MC-2.00*SEC
     ULC=MC+2.00*SEC
     ULT=MT+2.00*SET
     LLT=MT-2.00*SET
     J=O
     THROUGH L4, FOR I=1,1,I.E.60
     WHENEVER MC .G. EC(I), TRANSFER TO L4
     WHENEVER MC .L. EC(I), TRANSFER TO L5
     J=J+1.
L4   CONTINUE
L5   M=I
     PRC=(((M-J)+J/2)/60)*100
     K=O.
     THROUGH L6, FOR I=1,1,I   .E. 60
     WHENEVER MT .G. ET(I), TRANSFER TO L6
     WHENEVER MT  .L. ET(I), TRANSFER TO L7
     K=K+1.
L6   CONTINUE
L7   M=I
     PRT=(((M-K)+K/2)/60)*100
     MC(L)=MC
     MT(L)=MT
     SDC(L)=SDC
```

```
      SDT(L)=SDT
      PRINT FORMAT OUT20,L,Q,(1)...Q(10),ST(1)...ST(10)
      VECTOR VALUES OUT20=$1H1,14HINPUT CARD NO. I1,S1,6HREADS,,S1,
      110F1.O,1OF2.O*$
      PRINT FORMAT OUT1,L
      VECTOR VALUES OUT1=$1HO,S1,11HRUN NUMBER I1,//S4,48HCLASS NUM
      IBER    STANDARDIZED T SCORES FOR POST-/S23,27HACHIEVEMENT
      1     ATTITUDE*$
      THROUGH L8, FOR I=1,1,I G.30
L8    PRINT FORMAT OUT2, I,C(I),T(I)
      VECTOR VALUES OUT2=$1HO,S7,I2,S15,F4.0,S14,F4.0*$
      PRINT FORMAT  OUT3,MC,MT,SDC,SDT,LLC,ULC,LLT,ULT,PRC,PRT
      VECTOR VALUES OUT3=$1HO,S25,46HDESCRIPTIVE STATISTICS FOR ABO
      IVE DISTRIBUTIONS//S33,28HACHIEVEMENT   ATTITUDE//S1,4HM
      IEAN,S20,IH=,S10F4.0,S14F4.0//S1,18HSTANDARD DEVIATION,S6,IH
      1=,S12,F3.1,S15,F3.1//S1,22H95  PER  CENT CONFIDENCE/S1,17HINTER
      IVAL FOR MEAN,S7,1H=,S9,F3.0,1H-,F3.0,S11,F3.0,1H-,F3.0//S1,24
      1HPERCENTILE RANK  OF MEAN=,S11,F4.0,S14,F4.0*$
      TRANSFER  TO START
L9    THROUGH L11, FOR  H=1,1H.G. (L-1)
      THROUGH L10, FOR I=H 1,1,I.G.  L
      TC(H,I)=(MC(H)-MC(I))/SQRT.(.034*(SDC(H).P.2+SDC(I).P.2))
L10   TT(H,I)=(MT(H)-MT (I))/SQRT.( 034*(SDT(H).P,2+SDT(I).P.2))
L11   CONTINUE
```

```
    WHENEVER S. E. 1, TRANSFER TO NEW
    WHENEVER S. E  4, TRANSFER TO L13
    WHENEVER S. E. 3, TRANSFER TO L12
    PRINT FORMAT OUT4, TC(1, 2), TT(1, 2)
    VECTOR VALUES OUT4=$1H1, S23, 8HT-RATIOS//S1, 18HDEPENDENT VARIA
   IBLE, S2, 13HRUNS COMPARED//S24, 3H1-2, //S2, 11HACHIEVEMENT, S9, F5.
    11//S2. 8HATTITUDE, S12, F5. 1*$
    TRANSFER TO L14
L12  PRINT FORMAT OUT5, TC(1, 2), TC(1, 3), TC(2, 3), TT(1, 2), TT(1, 3), TT(
      12, 3)
     VECTOR VALUES OUT5=$1H1, S25, 8Ht-RATIOS//S1, 18HDEPENDENT VARIA
    IBLE, S4, 13HRUNS COMPARED//S24, 3H1-2, S4, 3H1-3, S4, 3H2-3//S2, 11HA
    1CHIEVEMENT, S9, F5. 1, 2(S2, F5. 1)//S2, 8HATTITUDE, S12, F5. 1, 2(S2, F5
    1. 1)*$
    TRANSFER TO L14
L13  PRINT FORMAT OUT6, TC(1, 2), TC(1, 3), TC(1, 4), TC(2, 3), TC(2, 4),
      TC(13, 4), TT(1, 2), TT(1, 3), TT(1, 4)TT(2, 3), TT(2, 4, TT(3, 4)
     VECTOR VALUES OUT6=$1H1, S35, 8HT*RATIOS, //S1, 18HDEPENDENT VARI
     IABLE, S13, 13HRUNS COMPARED//S24, 3H1-2, S4, 3H1-4, S4, 3H2
     1-3, S4, 3H2-4, S4, 3H3-4//S2, 11HACHIEVEMENT, S9, F5. 1, 5(S2, F5. 1)//S
     12, 8HATTITUDE, S12, F5. 1, 5(S2, F5. 1)///*$
L14  PRINT FORMAT OUT7
        VECTOR VALUES OUT7=$1HO, S1, 73HALL OF THE ABOVE T-RATIOS
WHICH IARE GREATER THAN OR EQUAL TO 2. 00 OR LESS/S1, 66HTHAN OR
 EQUAL  TO -2. 00 ARE SIGNIFICANT AT THE  . 05 LEVEL (2-TAILED)*$
L=O
```

```
NEW  TRANSFER TO START
          END OF PROGRAM
```

The immediate objective of the simulation aspect of this study was to develop a computer program to simulate relationships between selected classroom variables. The model developed generates probabilistic data which are consonant with empirical data produced by statistical analyses of a composite sample of sixty classes covering three different grade levels. However, the program does have many limitations. The sixty classes considered represented only sixth grade elementary, seventh grade social studies, and eighth grade mathematics content areas. Therefore, the model is likely not to apply to many teaching-learning situations unlike those depicted by this sample. Furthermore, the program has not been reality checked in many respects, it considers only linear associations, and it occasionally generates values which never occur in the real world. More can be said about the utility of this simulation program after subsequent reality checks and feedback regarding its success in generating and investigating hypotheses.

User Write-Up

Table 20 presents a copy of the description which would be given to a prospective user of the simulation program. Although it is assumed that persons interested in using the program would have some knowledge of interaction analysis, no familiarity with this particular study is needed. Consequently, much of the information presented in the following table is repetitious of what has been said above.

TABLE 20
User Write-Up for Interaction Analysis Data Simulation Program*

This computer program can be used to simulate distributions of average class achievement and attitude scores when levels of classroom ability and verbal interaction variables are specified.

To use the program one simply selects a level for each of ten classroom variables, and the program then generates a distribution of 30 probabilistic class scores for both achievement and attitude, the means and standard deviations of the simulated distributions, and 95% confidence intervals and percentile ranks for the means. If one simulates more than one distribution by selecting different combinations of input levels, then the model will print out t-ratios for statistical comparisons among all combinations of simulated distributions. The pairwise comparisons among distributions can be made for no more than four distributions (six comparisons) simultaneously. However, by simply repeating the cycle one can compare any number of simulated distributions with just one approach to the computer. The levels specified by the user must be either all quartiles or else all standardized T-scores for a particular simulation run.

Limitations: This program generates probabilistic data which are consistent with empirical data produced by statistical analyses of a composite sample of sixty classes covering three different grade levels. However, the program does have many limitations. The sixty classes considered represented only sixth grade elementary, seventh grade social studies, and eighth grade mathematics content areas. Therefore, the model is likely not to apply to many teaching learning situations unlike those depicted by this sample. Furthermore, the program has not been reality checked in many respects, it considers only linear associations, and it occasionally generates values which never occur in the real world.

Theoretical and operational definitions of the variables considered in the model are described below. If the reader is not familiar with the terminology used in the operational definitions he should consult that section of an article written by Flanders (1965) which refers to the 10x10 interaction analysis matrix.

NUMBER	NAME	DEFINITION
X_1	Pre-Achievement	THEORETICAL--knowledge of content material prior to a sustained teaching-learning experience; OPERATIONAL--scores on valid and reliable paper and pencil tests.
X_2	Pre-Attitude	THEORETICAL--students' attitudes toward the teacher, the teacher's method of teaching, and classroom activities in general prior to a sustained teaching-learning experience; OPERATIONAL--scores on valid and reliable paper and pencil attitude tests.
X_3	I. Q.	THEORETICAL--ratio of mental age to chronological age; OPERATIONAL--scores on valid and reliable standardized I. Q. tests.
X_4	i/(i+d) Ratio	THEORETICAL--ratio of expansive activity to expansive activity plus restrictive activity. OPERATIONAL--ratio of the number of tallies in columns 1-3 of a 10x10 matrix to the number of tallies in columns 1-3, 6, and 7.
X_5	Rebellion	THEORETICAL--percentage of time in which students do not comply with teacher directions and criticisms. OPERATIONAL--percentage of tallies in the (6, 9) and (7, 9) cells.
X_6	Content	THEORETICAL--percentage of time during which teacher either asks questions or lectures; OPERATIONAL--percentage of tallies in columns 4 and 5.
X_7	Drill	THEORETICAL--percentage of time during which teacher asks question, students respond, more questions, etc; OPERATIONAL--percentage of tallies in the (4, 8) and (8, 4) cells.

Table 20 Continued

Number	Name	Definition
X_8	Sustained Acceptance	THEORETICAL--percentage of time in which the teacher engages in sustained acceptance of student ideas; OPERATIONAL--percentage of tallies in the (3, 3) cell.
X_9	Praise	THEORETICAL--percentage of time during which the teacher praises students; OPERATIONAL--percentage of tallies in column 2.
X_{10}	Restrictive Feedback	THEORETICAL--percentage of time in which student responses are followed by restrictive teacher activity; OPERATIONAL--percentage of tallies in the (8, 6), (8, 7), (9, 6), and (9, 7) cells.

DECK ARRANGEMENT

Allow 30 seconds and 10 pages for each simulated distribution.

Add 20 additional seconds and 5 more pages for each set of t-tests.

A. 2 I.D. Cards

B. Binary Program (data cabinet in ORS)

C. Data Card(s)

When Quartile Levels are Used:

Column	Punch
2-11	Punch quartile levels (1 digit for each variable) for $X_1 \ldots X_{10}$ in columns 2-11 respectively. A '1' represents the top quartile, a '2' the 2nd highest quartile, etc. If quartile levels are not used punch zeros in Colunns 2-11.

When Standardized T-Scores are Used:

Column	Punch
12-31	Punch standardized T-scores (2 digits per variable) for $X_1 \ldots X_{10}$ in columns 12-31. The score for X_1 should be punched in columns 12 and 13, the score for X_2 in columns 13 and 14, etc. until the score for X_{10} is punched in columns 30 and 31. If standardized T-Score levels are not used punch zeros in columns 12-31. NOTE: Do not punch both quartile levels and standardized T-Scores in the same card.

D. Run Card

Column	Punch
1	Punch the number of data cards which precede the run card into column 1. The number of data cards preceding each run card must not exceed 4.

Additional simulated distributions, summary statistics, and pairwise t-tests may be generated with one approach to the computer by repeating steps C and D above as many times as desired.

*This program is written in the MAD language for use on the IBM 360 MOD 65 data processing system at The University of Michigan Computing Center. The program employs the RANDND. and SQRT. subroutines.

Sample Output

Table 21 contains four simulated distributions and one set of t-tests which were generated by one approach to the computer via the simulation program.

The table is identical in every respect to the computer print out with the exception of the topmost heading.

TABLE 21

Sample of Output Generated by Interaction Analysis Data Simulation Program

```
INPUT CARD NO. 1 READS, 1213332114 0 0 0 0 0 0 0 0 0 0

RUN NUMBER  1

CLASS NUMBER        STANDARDIZED T-SCORES FOR POST-
                      ACHIEVEMENT             ATTITUDE
       1                  60                     32
       2                  70                     46
       3                  65                     38
       4                  78                     45
       5                  61                     52
       6                  83                     38
       7                  73                     41
       8                  73                     33
       9                  69                     35
      10                  65                     42
      11                  60                     44
      12                  70                     47
      13                  70                     56
      14                  72                     42
      15                  67                     45
      16                  65                     40
      17                  69                     37
      18                  70                     45
      19                  71                     43
      20                  69                     47
      21                  77                     43
      22                  71                     57
      23                  73                     32
      24                  69                     51
      25                  77                     41
      26                  78                     47
      27                  75                     33
      28                  77                     32
      29                  66                     41
      30                  60                     46
 DESCRIPTIVE STATISTICS FOR ABOVE DISTRIBUTIONS
                                   ACHIEVEMENT              ATTITUDE
 MEAN                        =         70                      42
 STANDARD DEVIATION          =         5.7                      6.6
 95PER CENT CONFIDENCE INTERVAL
                    FOR MEAN =   60-81                 29-56
 PERCENTILE RANK OF MEAN =      100                    28
```

Table 21 - continued

```
INPUT CARD NO. 2 READS, 1212223441 0 0 0 0 0 0 0 0 0 0

 RUN NUMBER 2

    CLASS NUMBER          STANDARDIZED T-SCORES FOR POST-
                            ACHIEVEMENT          ATTITUDE

          1                     45                  67
          2                     42                  52
          3                     52                  62
          4                     60                  57
          5                     60                  66
          6                     55                  67
          7                     49                  56
          8                     53                  74
          9                     58                  74
         10                     49                  62
         11                     57                  61
         12                     53                  66
         13                     61                  59
         14                     45                  61
         15                     50                  62
         16                     59                  60
         17                     47                  66
         18                     51                  63
         19                     46                  62
         20                     57                  53
         21                     61                  68
         22                     53                  59
         23                     57                  53
         24                     54                  60
         25                     49                  51
         26                     56                  60
         27                     55                  64
         28                     56                  62
         29                     54                  55
         30                     55                  62

                              DESCRIPTIVE STATISTICS FOR ABOVE
                                                DISTRIBUTION
                              ACHIEVEMENT        ATTITUDE

MEAN        =                     53                 61

STANDARD DEVIATION   =             5.1                5.5

95 PERCENT CONFIDENCE
INTERVAL FOR MEAN    =      43-64             48-75

PERCENTILE RANK OF MEAN =  62                 90
```

Table 21 - continued

```
INPUT CARD NO. 3 READS, 3333332114 0 0 0 0 0 0 0 0 0 0

 RUN NUMBER 3

    CLASS NUMBER          STANDARDIZED T-SCORES FOR POST-
                            ACHIEVEMENT          ATTITUDE

         1                       54                  38
         2                       46                  40
         3                       46                  40
         4                       48                  46
         5                       56                  47
         6                       60                  38
         7                       47                  30
         8                       55                  49
         9                       59                  30
         10                      53                  46
         11                      53                  39
         12                      46                  44
         13                      54                  44
         14                      68                  33
         15                      56                  33
         16                      46                  37
         17                      54                  44
         18                      60                  35
         19                      51                  37
         20                      62                  32
         21                      64                  39
         22                      48                  35
         23                      51                  38
         24                      63                  30
         25                      49                  32
         26                      55                  37
         27                      54                  55
         28                      51                  44
         29                      56                  40
         30                      50                  32
DESCRIPTIVE STATISTICS FOR ABOVE DISTRIBUTIONS
                              ACHIEVEMENT       ATTITUDE
MEAN                =             54              39
STANDARD DEVIATION  =              5.8              6.1
95 PER CENT CONFIDENCE
INTERVAL FOR MEAN   =       43-64           26-52
PERCENTILE RANK OF MEAN =   62              18
```

Table 21 - continued

```
INPUT CARD NO. 4 READS, 2222223441 0 0 0 0 0 0 0 0 0 0

  RUN NUMBER 4

    CLASS NUMBER            STANDARDIZED T-SCORES FOR POST-
                              ACHIEVEMENT        ATTITUDE

         1                        51                60
         2                        49                72
         3                        56                64
         4                        45                58
         5                        53                51
         6                        47                50
         7                        57                64
         8                        54                51
         9                        50                62
        10                        44                61
        11                        51                55
        12                        49                62
        13                        44                58
        14                        46                56
        15                        40                59
        16                        44                73
        17                        52                65
        18                        40                56
        19                        47                59
        20                        47                59
        21                        44                56
        22                        50                58
        23                        46                60
        24                        43                72
        25                        37                60
        26                        43                62
        27                        48                71
        28                        49                70
        29                        51                66
        30                        50                62
  DESCRIPTIVE STATISTICS FOR ABOVE DISTRIBUTIONS
                              ACHIEVEMENT        ATTITUDE
  MEAN                 =          48                61
  STANDARD DEVIATION   =          4.6               6.0
  95 PER CENT CONFIDENCE
  INTERVAL FOR MEAN    =        37-58             48-74

  PERCENTILE RANK OF MEAN =       32                90
```

Table 21 - continued

DEPENDENT VARIABLE	T-RATIOS RUNS COMPARED					
	1-2	1-3	1-4	2-3	2-4	3-4
ACHIEVEMENT	11.9	10.9	16.7	-.2	4.6	4.5
ATTITUDE	-12.0	2.1	-11.3	14.9	.3	-14.1

CHAPTER V

SUMMARY AND IMPLICATIONS

Concluding remarks are presented in this chapter in an attempt to summarize the major features of the study and to suggest some salient implications for further research.

Summary of the Study

The objectives of this study were to analyze empirical data on thirty selected independent classroom variables and the dependent variables of class achievement and attitude in an effort to:

1. isolate those independent variables which had significant associations with the dependent variables of class achievement and/or attitude;
2. to calculate the strength of association between independent and dependent variables;
3. to determine the trend of association for all independent-dependent variable relationships;
4. to construct regression equations which represent the relative contributions of important independent variables in predicting achievement and attitude; and
5. to develop a computer simulation program which generates data for some aspects of an educational process.

The independent variables were divided into three uncontrollable classroom factors and twenty-seven controllable factors. The uncontrollable factors were Pre-Achievement, Pre-Attitude, and I.Q. Those variables which were considered to be partially controllable during a given classroom learning experience were related to the verbal interactions between the teacher and students. The verbal interaction variables considered here were called: i/d Ratio, Flexibility, i/(i+d) Ratio, I/D Ratio, I/(I+D) Ratio, Expansive Activity, Restrictive Activity, Indirect Activity, Direct Activity, Teacher Talk, Directed Student Response, Student Initiated Response, Student Talk, Small Vicious Circle, Big Vicious Circle, Rebellion, Teacher Questions, Teacher Lecture, Content, Content Cross, Drill, Lecture plus Drill, Sustained Acceptance, Sustained Expansive Activity, Praise, Reward, and Restrictive Feedback.

The sample was made up of twenty-nine general sixth grade classes, fifteen seventh grade social studies classes, and sixteen eighth grade mathematics classes, and an observation on any one of the variables consisted of one score per class.

The procedures for analyzing the data made use of descriptive statistics, analysis of variance models appropriate for the testing of significance, strength, and trend of associations, and regression analyses.

Principal findings based on combined grade level samples are:

(a) Pre-Achievement and I.Q. were the strongest predictors of Post-Achievement;

(b) Pre-Attitude was the best single predictor of Post-Attitude;

(c) Five verbal interaction variables (Expansive Activity, Indirect Activity, Small Vicious Circle, Sustained Acceptance, and Sustained Expansive Activity) had statistically significant pairwise associations with Post-Achievement;

(d) Ten verbal interaction variables ($i/(i+d)$ Ratio, Expansive Activity, Small Vicious Circle, Big Vicious Circle, Rebellion, Content Cross, Lecture plus Drill, Sustained Expansive Activity, Reward, and Restrictive Feedback) had statistically significant associations with Post-Attitude;

(e) Three interaction variables (Expansive Activity, Small Vicious Circle, Sustained Expansive Activity) had statistically significant associations with both Post-Attitude and Post-Achievement;

(f) In general, verbal interaction variables had stronger and more consistent associations with Post-Attitude than with Post-Achievement;

(g) Class attitudes were independent of class achievement;

(h) All statistically significant pairwise associations were essentially linear;

(i) Pre-Achievement plus I. Q. accounted for an estimated 91% of the variance in Post-Achievement.

(j) The addition of interaction variables to Pre-Achievement and I. Q. in regression equations used to predict Post-Achievement resulted in unbiased estimates for coefficients of determination which were larger by an average of . 05 over the prediction provided by just Pre-Achievement and I. Q. ;

(k) Pre-Attitude accounted for an estimated 61% of the variance in Post-Attitude.

(l) The inclusion of interaction variables with Pre-Attitude accounted for an average of 15% more of the variance in Post-Attitude than did Pre-Attitude alone.

These findings might have some immediate application to classroom instruction. However, the educational significance of the study is viewed here as relating primarily to implications for further research discussed in the next section.

A principal limitation of this study concerns the fact that some of the results may be misinterpreted. Those misinterpretations which do occur are likely to be a result of the necessity of using class scores instead of individual scores for all subjects involved. The use of the class score had two effects on the statistical analysis. One was to greatly reduce the within group variability, and the other was to reduce the size of the sample by a factor of about thirty. The reduction of the within group variability caused the correlations for means to be much larger than the corresponding correlations for individuals. And the substantial reduction in sample size tended to inflate the multiple correlation coefficients generated by the regression analysis.

Other limitations of the study concern the redundancy of information produced by the data analysis, the lack of emphasis on logical and cognitive aspects of classroom behavior, and the grossness of some of the categories.

The construction of the computer simulation program was based upon the relationships which existed in the composite sample of all sixty classes. Ten classroom variables were selected as predictor variables in the model. The ten variables are: Pre-Achievement Pre-Attitude, I.Q., $i/(i+d)$ Ratio, Rebellion, Content, Drill, Sustained Acceptance, Praise, and Restrictive Feedback. To use the exploratory model one needs only to specify levels for each of the variables, and the model will generate a simulated distribution of thirty probabilistic, but realistic, class scores for both achievement and attitude, means and standard deviations of the simulated distributions, 95% confidence intervals and percentile ranks for the means, and t-ratio comparisons for all simulated distributions.

At the present stage of development the simulation program has several limitations. Its applicability to teaching-learning situations unlike those represented by the composite sample is unknown, it considers only linear associations among variables, has not been reality checked in many respects, and occasionally generates values which never occur in the real world.

The model could be used to study the effect which various independent variable manipulations have on simulated class achievement and attitude scores, to generate hypotheses for situations where relation of simulated data to real data is unknown, and to simulate data for instructional purposes.

Implications for Further Research

Because this study was exploratory in many respects, and the results were often inconclusive, much of its educational significance relates to implications for further research. Three areas of research could be especially relevant extentions of this study. One involves the investigation of sequential patterns of verbal interaction variables. Another concerns research which controls for ability while analyzing associations between interaction variables and achievement. A third relates to the evaluation and use of the simulation program.

The regression analyses suggest that the interaction variables considered here may have been too restricted in scope to have cause-effect associations with broadly based measures of academic achievement. A research effort investigating associations which sequential combinations of these variables have with various aspects of school learning is needed. For example, sequential patterns consisting of lecture followed by drill might be appropriate for some teaching-learning situations while student initiated responses followed by teacher lecture may be applicable to others.

The detection of variables which are or are not associated with important educational outcomes can be a first step in research aimed at improving classroom instruction. But the ultimate goal of such research should be to determine the cause-effect nature of the associations. The extent to which the significant pairwise associations found in this study represent cause-effect relationships was largely indeterminable. Hence, an experiment which controls for the ability level of classes by matching samples, manipulates levels of potentially important interaction variables, and then investigates the resulting relationships between interaction variables and achievement would be a logical extension of this study.

Currently the simulation program generates data which are largely indistinguishable from the data obtained from the total sample of all sixty classes. But the generalizability of the model to other educational situations is unknown. This generalizability could be partially ascertained if research was undertaken which compared the distributions simulated by the program with empirical distributions obtained from a variety of different samples.

Research which compares simulated distributions produced by various manipulations of independent variable levels might also prove to be fruitful. If the results of these comparisons were stated in the form of hypotheses to be investigated, then the model could be used as a generator of hypotheses to be investigated.

APPENDICES

APPENDIX A

Interaction Analysis Matrix

Tabulation

Trained observers used the categories in Table 2 of Chapter II to collect data on spontaneous verbal interactions in the classes by writing down in sequence and every three seconds, the number of the category which represented the kind of verbal communication that had taken place during the preceding three second period. Observers also made notes related to different time use categories and other occurrences of special interest. The time use categories for which data were gathered were: administrative routine, evaluation, work, new material, and discussion. So, at the end of an observation period, an observer had a sequential list of arabic numerals and a few notes. The list of numerals was then transformed into 10 by 10 matrices similar to figure 1.

(next page)

EXAMPLE OF INTERACTION MATRIX [a]

Category	1	2	3	4	5	6	7	8	9	10	Sum
1	3	0	1	6	15	3	0	2	7	5	42
2	1	6	7	19	26	6	0	5	11	14	95
3	2	8	112	123	159	15	3	49	128	33	632
4	4	3	5	136	50	14	3	617	94	57	983
5	12	21	20	285	1571	80	9	115	95	140	2348
6	0	0	2	25	70	26	2	26	26	51	208
7	0	3	1	5	15	2	6	3	7	9	51
8	9	37	222	271	222	20	8	365	33	64	1251
9	6	12	255	42	60	10	5	5	507	17	919
10	5	5	7	71	161	33	15	64	31	279	671
Total	42	95	632	983	2348	208	51	1251	919	671	7200

Figure 4

[a] Adapted from Morrison (1966, p. 135).

In order to see how the conversion of a sequential series of numbers into a matrix took place, consider the short series 4,8,4,5,6,7,6,7,7,5,5,4,8,9,3,3,2,5. First of all, a 10 was added to the beginning and end of a series when necessary to insure that it began and ended with a ten.

This procedure was followed to insure that the sum of row I is equal to the sum of column J for all J= I. Our original series now becomes 10,4,8,4,5,6,7,6,7,7,5,5,5,4,8,9,3,3,2,5,10. A tally for each sequential pair was then entered into a matrix cell whose row number equaled the first member of the ordered pair and whose column number equaled the second member. Using the above list, a tally would have been placed in cell (10,4) for the first sequence of events, in cell (4,8) for the next sequence, and so forth in an overlapping fashion until a tally for the last pair (5,10) was entered in the row 5 and column 10 cell (figure 2). Modern data processing techniques were used to transform the observers' sequential lists into matrices.

Figure 5

10 by 10 Matrix

Category	1	2	3	4	5	6	7	8	9	10	Sum
1											
2					1						1
3		1	1								2
4					1			2			3
5				1	2	1				1	5
6							2				2
7					1	1	1				3
8				1					1		2
9			1								1
10				1							1
Total		1	2	3	5	2	3	2	1	1	20

The reader should note that the sum of the tallies in an area of the matrix divided by the total number of tallies in the matrix represents the percentage of observation time in which the class was engaged in the type of activity represented by the area of interest. As suggested earlier, hundreds of verbal interaction variables can be operationalized by calculating the percentage of class time spent in various areas of the matrix. For example, the percentage of tallies in the (4,8) and (8,4) cells combined gives an indication of the proportion of time used to drill students. That is, teacher asks a question, student responds, another teacher question, etc. In a like manner, variables such as the percentage of time spent lecturing, asking questions, accepting student ideas, student talk, rewarding student responses, etc, can also be operationalized.

APPENDIX B

Variable Distributions

by Grade Level

TABLE 22

Summary Statistics for Variable Distribution in Twenty-nine Sixth Grade Classes

Independent Variable	Mean	Standard Deviation	Range
V_1	50	10	22.00-65.00
V_2	50	10	31.00-67.00
V_3	50	10	24.00-67.00
V_4	1.27	0.72	0.33- 3.19
V_5	1.60	1.70	0.27- 3.76
V_6	0.52	0.14	0.23- 0.76
V_7	0.56	0.20	0.20- 0.94
V_8	0.35	0.08	0.17- 0.49
V_9	8.00	2.30	3.83-12.41
V_{10}	7.47	2.84	3.60-15.30
V_{11}	18.03	4.37	9.34-27.35
V_{12}	34.50	8.74	21.00-56.56
V_{13}	53.49	9.50	37.10-73.61
V_{14}	21.01	9.43	4.36-51.45
V_{15}	11.22	4.64	1.09-21.96
V_{16}	32.23	8.97	18.09-54.46
V_{17}	0.28	0.27	0.06- 1.13
V_{18}	3.18	1.69	0.50- 8.26
V_{19}	0.64	0.50	0.12- 1.94
V_{20}	10.03	2.84	5.00-17.67
V_{21}	27.01	8.49	14.40-48.18
V_{22}	37.05	8.96	22.92-59.35
V_{23}	50.90	9.81	33.28-73.26
V_{24}	7.44	2.39	2.86-12.17
V_{25}	34.45	8.61	21.26-56.60
V_{26}	1.36	0.74	0.40- 2.97
V_{27}	1.75	0.94	0.46- 4.29
V_{28}	0.93	0.52	0.18- 2.11
V_{29}	5.42	1.44	2.68- 8.91
V_{30}	1.23	0.76	0.60- 3.67
Dependent Variable			
V_{31}	50	10	32.00-67.00
V_{32}	50	10	22.00-66.00

TABLE 23

Summary Statistics for Variable Distributions in Fifteen Seventh Grade Classes

Independent Variable	Mean	Standard Deviation	Range
V_1	50	10	34.00-68.00
V_2	49.7	9.6	34.00-65.00
V_3	52.5	8.9	36.00-70.00
V_4	1.01	0.94	0.07- 3.26
V_5	4.21	4.91	0.28-15.12
V_6	0.40	0.22	0.07- 0.76
V_7	0.48	0.24	0.10- 0.88
V_8	0.31	0.11	0.09- 0.46
V_9	6.75	3.49	1.54-12.39
V_{10}	11.59	6.44	3.51-26.28
V_{11}	17.89	6.76	5.29-29.12
V_{12}	41.28	10.88	28.74-63.07
V_{13}	59.08	9.52	41.17-81.36
V_{14}	19.14	9.62	4.38-40.94
V_{15}	9.09	3.23	4.80-14.84
V_{16}	28.23	9.77	12.86-49.82
V_{17}	0.63	0.48	0.07- 1.66
V_{18}	5.28	4.06	1.55-17.07
V_{19}	0.75	0.61	0.07- 1.96
V_{20}	11.14	4.76	3.27-20.07
V_{21}	29.69	12.07	16.82-59.56
V_{22}	40.89	10.30	26.85-66.48
V_{23}	53.73	9.03	39.06-72.60
V_{24}	8.11	3.67	3.76-14.36
V_{25}	37.80	10.39	24.47-64-80
V_{26}	1.29	1.30	0.00- 3.61
V_{27}	1.67	1.42	0.13- 4.19
V_{28}	1.30	0.81	0.26- 3.25
V_{29}	4.47	2.22	1.16- 7.87
V_{30}	1.78	1.27	0.13- 4.66
Dependent Variable			
V_{31}	48.70	10.61	32.00-62.00
V_{32}	50.00	10.00	23.00-65.00

TABLE 24

Summary Statistics for Variable Distributions in Sixteen Eighth Grade Classes

Independent Variable	Mean	Standard Deviation	Range
V_1	50	10	32.00-64.00
V_2	50.2	10.4	33.00-62.00
V_3	47.6	10.3	31.00-66.00
V_4	1.40	1.49	0.10- 5.17
V_5	2.84	2.88	0.09- 8.96
V_6	0.44	0.26	0.09- 0.84
V_7	0.39	0.24	0.09- 0.87
V_8	0.26	0.11	0.09- 0.47
V_9	6.53	3.59	0.98-14.77
V_{10}	9.81	6.81	2.03-29.80
V_{11}	17.79	7.63	6.81-29.00
V_{12}	51.61	11.48	32.91-73.22
V_{13}	69.39	9.33	47.63-82.33
V_{14}	11.81	6.15	2.89-24.73
V_{15}	6.75	3.82	0.45-13.63
V_{16}	18.65	7.30	9.68-35.80
V_{17}	0.55	0.94	0.00- 4.05
V_{18}	3.83	3.73	0.64-16.07
V_{19}	0.77	1.09	0.00- 4.61
V_{20}	11.13	5.22	3.60-18.76
V_{21}	41.79	14.13	18.85-63.52
V_{22}	52.92	13.85	22.45-73.45
V_{23}	67.00	13.54	31.27-85.53
V_{24}	9.51	6.33	2.38-14.38
V_{25}	51.28	12.81	21.24-68.60
V_{26}	1.52	1.51	0.00- 5.48
V_{27}	2.01	1.77	0.08- 6.26
V_{28}	1.38	0.82	0.10- 3.76
V_{29}	4.21	2.58	0.25-10.15
V_{30}	1.91	1.48	0.10- 5.02
Dependent Variable			
V_{31}	51.20	10.60	31.00-64.00
V_{32}	50.00	10.00	31.00-63.00

APPENDIX C

Correlation Analyses

by Grade Level

TABLE 25

Intercorrelations of T-scores for Sixth Grade

Variables	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}	V_{14}	V_{15}	V_{16}	V_{17}	V_{18}
V_1	1.00																	
V_2	.26	1.00																
V_3	.90	.38	1.00															
V_4	.46	.57	.40	1.00														
V_5	-.06	.05	-.02	.40	1.00													
V_6	.49	.58	.44	.94	.37	1.00												
V_7	.21	.35	.29	.49	.64	.58	1.00											
V_8	.26	.37	.33	.52	.60	.62	.99	1.00										
V_9	.35	.68	.37	.83	.32	.86	.58	.60	1.00									
V_{10}	-.46	-.34	-.38	-.77	-.31	-.86	-.48	-.53	-.51	1.00								
V_{11}	.21	.58	.22	.69	.56	.79	.75	.75	.82	-.56	1.00							
V_{12}	-.20	-.07	-.31	-.14	-.40	-.18	-.74	-.75	-.12	.25	-.17	1.00						
V_{13}	.07	.29	-.00	.16	-.13	.19	-.35	-.36	.18	-.09	.23	.77	1.00					
V_{14}	-.09	-.17	-.00	-.09	.17	-.07	.46	.46	-.22	-.13	-.05	-.65	-.65	1.00				
V_{15}	.29	.15	.28	.11	-.23	.11	-.22	-.16	.10	-.07	-.23	-.09	.04	-.34	1.00			
V_{16}	.06	-.10	.15	-.02	.06	-.01	.38	.41	-.17	-.19	-.16	-.73	-.65	.87	.16	1.00		
V_{17}	-.52	-.29	-.44	-.57	-.27	-.73	-.47	-.51	-.45	.88	-.59	.15	-.17	-.09	.15	-.03	1.00	
V_{18}	-.37	-.29	-.32	-.65	-.31	-.76	-.47	-.52	-.41	.91	-.54	.23	-.05	-.24	.03	-.25	.82	1.00

TABLE 25-continued

Variables	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}	V_{14}	V_{15}	V_{16}	V_{17}	V_{18}
V_{19}	-.45	-.35	-.43	-.55	-.25	-.67	-.55	-.57	-.50	.71	-.68	.13	-.23	-.13	.34	.02	.85	.64
V_{20}	.04	.35	.03	.41	.58	.54	.69	.68	.46	-.48	.89	-.16	.22	.09	-.41	-.11	-.57	-.53
V_{21}	-.05	.06	-.19	.13	-.29	.12	-.58	-.59	.06	-.09	.03	.94	.83	-.63	-.07	-.70	-.15	-.06
V_{22}	-.03	.15	-.16	.24	-.10	.27	-.35	-.36	.19	-.21	.29	.85	.85	-.59	-.19	-.71	-.31	-.22
V_{23}	-.05	.19	-.18	.26	-.03	.31	-.23	-.24	.22	-.26	.40	.78	.81	-.50	-.28	-.66	-.36	-.29
V_{24}	-.01	.24	-.07	.31	.37	.40	.61	.61	.22	-.48	.65	-.24	.00	.38	-.50	.15	-.51	-.59
V_{25}	-.05	.11	-.21	.21	-.19	.22	-.41	-.42	.11	-.21	.20	.86	.80	-.52	-.21	-.65	-.28	-.22
V_{26}	.45	.60	.43	.68	.03	.76	.33	.37	.82	-.55	.60	.01	.25	-.33	.26	-.21	-.54	-.38
V_{27}	.40	.62	.40	.65	.07	.72	.38	.41	.84	-.48	.64	-.02	.24	-.35	.25	-.24	-.49	-.33
V_{28}	.04	.33	.03	.31	.43	.36	.47	.45	.47	-.22	.53	-.15	.11	-.12	.05	-.10	-.26	-.26
V_{29}	.27	.54	.30	.79	.37	.77	.57	.58	.88	-.43	.73	-.16	.06	-.04	-.06	-.06	-.31	-.37
V_{30}	-.42	-.43	-.38	-.58	-.03	-.64	-.08	-.10	-.49	-.63	-.45	-.25	-.54	.43	-.03	.42	.62	.43
V_{31}	.14	.87	.21	.51	.04	.46	.27	.27	.50	-.30	.48	.05	.35	-.10	-.01	-.11	-.24	-.29
V_{32}	.99	.32	.91	.45	-.06	.49	.24	.29	.38	-.46	.22	-.24	.06	-.08	.31	.07	-.52	-.36

TABLE 25-continued

Variables	V_{19}	V_{20}	V_{21}	V_{22}	V_{23}	V_{24}	V_{25}	V_{26}	V_{27}	V_{28}	V_{29}	V_{30}	V_{31}	V_{32}
V_{19}	1.00													
V_{20}	-.66	1.00												
V_{21}	-.12	.02	1.00											
V_{22}	-.31	.30	.96	1.00										
V_{23}	-.38	.44	.90	.98	1.00									
V_{24}	-.61	.83	-.07	.16	.33	1.00								
V_{25}	-.28	.23	.96	.98	.97	.19	1.00							
V_{26}	-.44	.29	.21	.28	.26	.02	.20	1.00						
V_{27}	-.43	.33	.15	.25	.22	.03	.16	.96	1.00					
V_{28}	-.30	.44	-.08	.07	.08	.25	-.02	.28	.48	1.00				
V_{29}	-.43	.41	-.02	.11	.18	.32	.07	.54	.53	.20	1.00			
V_{30}	.63	-.31	-.48	-.54	-.53	-.15	-.50	-.59	-.55	-.14	-.32	1.00		
V_{31}	-.31	.34	.16	.24	.27	.31	.23	.42	.47	.36	.40	-.39	1.00	
V_{32}	-.45	.04	-.09	-.06	-.09	-.01	-.09	.47	.43	.09	.28	-.43	.19	1.00

TABLE 26

Intercorrelations of T-scores for Seventh Grade

Variables	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}	V_{14}	V_{15}	V_{16}	V_{17}	V_{18}
V_1	1.00																	
V_2	-.52	1.00																
V_3	.66	-.20	1.00															
V_4	.06	.30	.35	1.00														
V_5	.17	.14	.45	.55	1.00													
V_6	.23	.19	.47	.94	.65	1.00												
V_7	.33	-.00	.24	.14	.13	.36	1.00											
V_8	.40	-.09	.32	.18	.13	.40	.98	1.00										
V_9	.16	.16	.33	.85	.41	.92	.52	.55	1.00									
V_{10}	-.41	-.18	-.66	-.78	-.68	-.87	-.33	-.41	-.68	1.00								
V_{11}	.38	.06	.24	.42	.17	.58	.91	.92	.74	-.47	1.00							
V_{12}	-.34	.28	-.29	.30	.01	.09	-.77	-.79	-.01	.11	-.49	1.00						
V_{13}	-.13	.34	-.15	.64	.16	.52	-.26	-.27	.51	-.23	.12	.80	1.00					
V_{14}	.22	-.18	.28	-.31	.13	-.21	.30	.33	-.31	-.07	.01	-.70	-.78	1.00				
V_{15}	.28	-.12	.40	-.01	-.15	-.12	.25	.24	.30	-.06	.19	-.22	-.14	-.12	1.00			
V_{16}	.32	-.22	.42	-.30	.09	-.16	.39	.42	-.19	-.10	.09	-.77	-.82	.94	.21	1.00		
V_{17}	-.56	-.12	-.72	-.70	-.54	-.76	-.34	-.41	-.61	.92	.49	.15	-.18	-.05	-.13	-.10	1.00	
V_{18}	-.48	-.14	-.70	-.64	-.52	-.75	-.44	-.53	-.63	.93	-.54	.27	-.09	-.20	-.17	-.27	.85	1.00

TABLE 26-continued

Variables	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}	V_{14}	V_{15}	V_{16}	V_{17}	V_{18}
V_{19}	-.45	-.08	-.48	-.70	-.59	-.77	-.41	-.47	-.62	.89	-.55	.18	-.19	-.04	.08	-.02	.90	.76
V_{20}	.42	-.05	.10	-.03	-.07	.15	.90	.90	.33	-.16	.88	-.68	-.19	.23	.07	.26	-.25	-.31
V_{21}	-.08	.33	.08	.67	.34	.53	-.53	-.50	.34	-.42	-.20	.85	.85	-.62	-.16	-.67	-.34	-.24
V_{22}	.09	.36	.15	.78	.38	.69	-.22	-.19	.55	-.57	.15	.69	.90	-.61	-.16	-.65	-.52	-.41
V_{23}	.20	.41	.13	.68	.25	.65	.06	.07	.61	-.54	.41	.49	.85	-.57	-.05	-.57	-.51	-.49
V24	.39	.05	.23	-.16	-.16	-.00	.80	.81	.16	-.11	.72	-.71	-.32	.42	.14	.48	-.18	-.36
V_{25}	.06	.40	.20	.74	.36	.62	-.32	-.29	.45	-.55	.03	.73	.86	-.55	-.15	-.58	-.48	-.43
V_{26}	.16	.11	.38	.96	.62	.93	.15	.20	.83	-.79	.39	.22	.54	-.25	-.01	-.24	-.72	-.62
V_{27}	.17	.14	.38	.96	.65	.95	.25	.29	.87	-.79	.49	.16	.53	-.22	.00	-.20	-.72	-.64
V_{28}	.17	-.01	-.01	-.07	-.12	-.01	.37	.33	.18	.23	.47	-.06	.24	-.08	.01	-.06	.15	.09
V_{29}	.18	.15	.34	.71	.27	.82	.62	.64	.97	-.60	.80	-.13	.40	-.29	.46	-.13	-.55	-.59
V_{30}	-.13	-.25	-.31	-.73	-.64	-.73	-.07	-.08	-.52	.75	-.21	-.17	-.35	.22	.13	.26	.75	.48
V_{31}	-.17	.69	.09	.41	.09	.34	.13	.10	.32	-.44	.18	.03	.16	-.14	.14	-.08	-.44	-.40
V_{32}	.80	-.13	.86	.32	.33	.45	.42	.48	.36	-.69	.45	-.37	-.10	.13	.38	.28	-.82	-.75

TABLE 26-continued

Variables	V_{19}	V_{20}	V_{21}	V_{22}	V_{23}	V_{24}	V_{25}	V_{26}	V_{27}	V_{28}	V_{29}	V_{30}	V_{31}	V_{32}
V_{19}	1.00													
V_{20}	-.32	1.00												
V_{21}	-.31	-.52	1.00											
V_{22}	-.50	-.18	.93	1.00										
V_{23}	-.47	.15	.74	.92	1.00									
V_{24}	-.13	.90	-.58	-.29	.07	1.00								
V_{25}	-.42	-.29	.96	.98	.88	-.31	1.00							
V_{26}	-.74	-.04	.60	.69	.57	-.22	.63	1.00						
V_{27}	-.74	.05	.54	.67	.58	-.12	.59	.99	1.00					
V_{28}	.26	.54	-.17	.03	.27	.57	-.01	-.15	-.05	1.00				
V_{29}	-.53	.43	.20	.42	.54	.29	.33	.67	.72	.24	1.00			
V_{30}	.84	.09	-.55	-.61	-.44	.31	-.53	-.76	-.74	.44	-.40	1.00		
V_{31}	-.35	.01	.25	.30	.36	.06	.31	.34	.34	-.33	.32	-.47	1.00	
V_{32}	-.63	.38	.04	.21	.32	.42	.20	.35	.36	.01	.39	-.39	.26	1.00

TABLE 27

Intercorrelations of T-scores for Eighth Grade

Variables	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}	V_{14}	V_{15}	V_{16}	V_{17}	V_{18}
V_1	1.00																	
V_2	-.19	1.00																
V_3	.72	-.23	1.00															
V_4	.09	.46	.35	1.00														
V_5	-.10	.26	.25	.89	1.00													
V_6	.04	.48	.31	.92	.91	1.00												
V_7	-.00	.13	.15	.37	.51	.50	1.00											
V_8	.07	.15	.21	.43	.53	.56	.99	1.00										
V_9	-.01	.14	.23	.66	.82	.81	.69	.73	1.00									
V_{10}	.12	-.51	-.17	-.70	-.66	-.77	-.34	-.39	-.48	1.00								
V_{11}	.03	.29	.25	.56	.63	.70	.93	.96	.78	-.53	1.00							
V_{12}	-.25	.19	-.13	-.04	-.16	-.09	-.76	-.77	-.41	-.15	-.58	1.00						
V_{13}	-.27	.45	.05	.41	.30	.45	-.20	-.18	.11	-.61	.08	.76	1.00					
V_{14}	.29	-.13	.15	-.10	-.10	-.07	.58	.61	.03	-.06	.45	-.73	-.53	1.00				
V_{15}	.21	-.48	-.00	-.22	-.13	-.30	-.02	-.04	-.00	.49	-.24	-.48	-.76	.04	1.00			
V_{16}	.36	-.37	.13	-.20	-.16	-.22	.48	.49	.03	.20	.25	-.85	-.84	.86	.54	1.00		
V_{17}	.04	-.29	-.19	-.41	-.39	-.51	-.32	-.37	-.33	.89	-.45	-.07	-.44	-.33	.47	-.04	1.00	
V_{18}	.11	-.45	-.07	-.58	-.56	-.68	-.44	-.49	-.46	.95	-.57	.02	-.43	-.29	.42	-.03	.94	1.00

TABLE 27-continued

Variables	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}	V_{14}	V_{15}	V_{16}	V_{17}	V_{18}
V_{19}	.14	-.38	-.19	-.45	-.40	-.53	-.23	-.27	-.33	.87	-.41	-.28	-.66	-.12	.66	.23	.94	.85
V_{20}	.04	.32	.19	.31	.31	.44	.86	.87	.42	-.42	.89	-.54	.04	.62	-.35	.33	-.42	-.51
V_{21}	-.25	.40	-.02	.31	.18	.30	-.46	-.43	-.11	-.60	-.22	.88	.91	-.56	-.62	-.78	-.48	-.44
V_{22}	-.25	.53	.05	.44	.32	.48	-.13	-.10	.06	-.78	.13	.68	.94	-.32	-.76	-.66	-.66	-.65
V_{23}	-.27	.52	.02	.36	.25	.45	.11	.13	.09	-.80	.32	.48	.84	-.06	-.79	-.46	-.74	-.73
V_{24}	.03	.11	.08	-.02	.04	.11	.80	.77	.20	-.17	.69	-.62	-.22	.73	-.16	.53	-.29	-.33
V_{25}	-.28	.50	.01	.34	.24	.40	-.10	-.09	.01	-.76	.11	.66	.90	-.26	-.76	-.61	-.67	-.65
V_{26}	.25	.23	.42	.83	.79	.78	.31	.36	.75	-.52	.46	-.08	.27	-.21	.02	-.16	-.31	-.42
V_{27}	.15	.25	.37	.86	.85	.84	.38	.43	.83	-.57	.54	-.10	.31	-.19	-.05	-.18	-.36	-.47
V_{28}	-.20	-.04	.05	.35	.57	.51	.60	.62	.72	-.38	.60	-.38	-.01	.32	-.13	.19	-.45	-.45
V_{29}	-.04	.12	.13	.42	.57	.62	.80	.82	.88	-.33	.82	-.59	-.08	.22	.05	.22	-.24	-.37
V_{30}	.24	-.55	-.13	-.71	-.62	-.73	-.11	-.15	-.39	.91	-.36	-.43	-.82	.28	.58	.53	.69	.77
V_{31}	-.35	.73	-.06	.50	.44	.59	.33	.36	.39	-.65	.52	.17	.59	-.01	-.65	-.35	-.58	-.62
V_{32}	.92	-.19	.88	.25	.08	.20	.12	.19	.11	.03	.19	-.24	-.13	.26	.04	.25	.02	.08

TABLE 27-continued

Variables	V_{19}	V_{20}	V_{21}	V_{22}	V_{23}	V_{24}	V_{25}	V_{26}	V_{27}	V_{28}	V_{29}	V_{30}	V_{31}	V_{32}
V_{19}	1.00													
V_{20}	-.36	1.00												
V_{21}	-.64	-.23	1.00											
V_{22}	-.79	.15	.93	1.00										
V_{23}	-.82	.42	.77	.94	1.00									
V_{24}	-.17	.87	-.42	-.09	.22	1.00								
V_{25}	-.79	.17	.90	.98	.95	.03	1.00							
V_{26}	-.35	.10	.18	.23	.10	-.17	.14	1.00						
V_{27}	-.41	.17	.19	.26	.16	-.13	.17	.98	1.00					
V_{28}	-.40	.39	-.14	.01	.13	.33	.02	.26	.41	1.00				
V_{29}	-.21	.58	-.32	-.10	-.03	.41	-.13	.46	.54	.63	1.00			
V_{30}	.79	-.24	-.78	-.89	-.83	.09	-.83	-.53	-.58	-.20	-.22	1.00		
V_{31}	-.71	.46	.44	.63	.68	.28	.63	.32	.39	.38	.28	-.62	1.00	
V_{32}	.06	.19	-.20	-.14	-.15	.13	-.17	.31	.23	-.09	.06	.10	-.23	1.00

TABLE 28

Correlations between Independent and Dependent Variable T-Scores by Grade Level

Independent Variable	Dependent Variable							
	Post Achievement				Post Attitude			
	6th	7th	8th	all	6th	7th	8th	all
V_1	.99	.80	.92	.92	.14	-.17	-.35	-.06
V_2	.32	-.13	-.19	.07	.87	.69	.73	.78
V_3	.91	.86	.88	.88	.21	.09	-.06	.09
V_4	.45	.32	.25	.31	.51	.41	.50	.46
V_5	-.06	.33	.08	.13	.04	.09	.44	.13
V_6	.49	.45	.20	.35	.46	.34	.59	.43
V_7	.24	.42	.12	.24	.27	.13	.33	.22
V_8	.29	.48	.19	.29	.27	.10	.36	.21
V_9	.38	.36	.11	.27	.50	.32	.39	.39
V_{10}	-.46	-.69	.03	-.31	-.30	-.44	-.65	-.42
V_{11}	.22	.45	.19	.27	.48	.18	.52	.38
V_{12}	-.24	-.37	-.24	-.22	.05	.03	.17	.09
V_{13}	.06	-.10	-.13	-.02	.35	.16	.59	.32
V_{14}	-.08	.13	.26	.04	-.10	-.14	-.01	-.12
V_{15}	.31	.38	.04	.23	-.01	.14	-.65	-.13
V_{16}	.07	.28	.25	.14	-.11	-.08	-.35	-.16
V_{17}	-.52	-.82	.02	-.27	-.24	-.44	-.58	-.37
V_{18}	.36	-.75	.08	-.31	-.29	-.40	-.62	-.41
V_{19}	-.45	-.63	.06	-.26	-.31	-.35	-.71	-.44
V_{20}	.04	.38	.19	.19	.34	.01	.46	.26
V_{21}	.09	.04	-.20	-.08	.16	.25	.44	.27
V_{22}	-.06	.21	-.14	-.02	.24	.30	.63	.35
V_{23}	-.09	.32	-.15	-.02	.27	.36	.68	.38
V_{24}	-.01	.42	.13	.14	.31	.06	.28	.22
V_{25}	-.09	.20	-.17	-.03	.23	.31	.63	.34
V_{26}	.47	.35	.31	.35	.42	.34	.32	.34
V_{27}	.43	.36	.23	.32	.47	.34	.39	.39
V_{28}	.09	.01	-.09	.01	.36	-.33	.38	.14
V_{29}	.28	.39	.06	.22	.40	.32	.28	.31
V_{30}	-.43	-.39	.10	-.20	-.39	-.47	-.62	-.45

TABLE 29

Correlations between Independent Variable Quartile Levels and Dependent Variable T-Scores by Grade Level

Independent Variable	Dependent Variable							
	Post Achievement				Post Attitude			
	6th	7th	8th	all	6th	7th	8th	all
V1	.84	.76	.80	.80	.09	-.11	-.35	-.10
V2	.24	-.41	-.18	.05	.67	.52	.77	.72
V3	.73	.73	.84	.75	.22	-.13	-.09	,08
V4	.47	.53	.40	.29	.47	.23	.56	.48
V5	-.04	.46	.07	.22	.13	.28	.57	.27
V6	.47	.53	.40	.29	.47	.23	.56	.48
V7	.13	.28	.31	.16	.29	.04	.38	.18
V8	.13	.28	.31	.16	.29	.04	.38	.18
V9	.32	.34	.13	.29	.44	.27	.50	.40
V10	-.32	-.44	-.06	-.28	-.31	-.45	-.52	-.34
V11	.16	.33	.26	.25	.48	.23	.42	.34
V12	-.10	-.36	-.25	-.21	.03	-.09	.28	.04
V13	.02	-.16	.01	-.08	.30	.23	.45	.32
V14	-.01	.19	.32	.10	-.15	-.16	.09	-.17
V15	.25	.22	.09	.19	-.14	.09	-.64	-.14
V16	.15	.32	.11	.19	-.19	-.10	-.22	-.15
V17	-.42	-.69	-.21	-.36	-.38	-.39	-.29	-.38
V18	-.12	-.53	-.22	-.22	-.26	-.38	-.48	-.31
V19	-.31	-.48	.01	-.27	-.46	-.42	-.63	-.42
V20	-.02	.35	.17	.10	.37	-.10	.48	.32
V21	-.10	-.04	-.23	-.01	.07	.24	.41	.26
V22	.02	132	-.13	-.06	.28	.34	.56	.33
V23	-.11	.32	-.06	.01	.21	.34	.47	.41
V24	-.11	.44	.07	.09	.09	.03	.20	.12
V25	-.08	.22	-.08	-.02	.22	.35	.48	.34
V26	.48	.33	.41	.37	.43	.20	.22	.31
V27	.43	-.57	.20	.37	.41	.25	.30	.39
V28	.22	-.13	.21	.08	.50	-.35	.43	.21
V29	.15	.41	.25	.21	.27	.25	.49	.32
V30	-.37	-.45	-.07	-.28	-.34	-,33	-.48	-.35

APPENDIX D

Analyses of Variance
by Grade Level

TABLE 30

Analysis of Variance F Ratios for 29 Sixth Grade Classes

Independent Variable	Dependent Variable: Post Achievement			Dependent Variable: Post Attitude		
	Linear Regression	Curvilin Regression	Over all	Linear Regression	Curvilin Regression	Over all
V_1	66.22**	1.28	22.92**	.20	.96	.70
V_2	1.69	1.53	1.59	22.24**	1.29	8.27**
V_3	34.19**	2.24	12.89**	1.37	.78	.97
V_4	8.06**	2.07	4.07*	7.02	110	2.41
V_5	.05	.83	.57	.45	.83	.70
V_6	8.06**	2.07	4.07*	7.02	.10	2.41
V_7	.45	.31	.35	2.62	1.45	1.84
V_8	.45	.31	.35	2.62	1.45	1.84
V_9	3.15	1.50	2.05	6.48	.87	2.75
V_{10}	2.95	.34	1.21	2.89	.89	1.56
V_{11}	.63	.24	.37	7.57	.21	2.67
V_{12}	.32	2.41	1.71	.02	.45	.30
V_{13}	.01	.67	.45	2.66	.77	1.40
V_{14}	.01	2.39	1.60	.61	.61	.60
V_{15}	1.88	1.54	1.65	.51	.05	.21
V_{16}	.55	.14	.28	1.12	2.87	2.29
V_{17}	7.42*	4.91	5.75**	4.20	.19	1.53
V_{18}	.44	1.49	1.14	1.85	.75	1.12
V_{19}	3.01	1.53	2.04	6.89*	.28	2.48
V_{20}	.01	.42	.29	4.14	.25	1.55
V_{21}	.26	.34	.31	1.28	.63	.46
V_{22}	.01	.37	.25	2.17	.18	.84
V_{23}	.30	.77	.61	1.48	3.23	2.65
V_{24}	.35	2.28	1.64	.24	1.04	.77
V_{25}	.17	.45	.36	1.24	.22	.56
V_{26}	9.71**	3.91*	5.85**	6.66*	1.98	3.54*
V_{27}	7.26*	3.63*	4.84**	5.49	1.02	2.51
V_{28}	1.44	2.09	1.87	9.08**	1.31	3.90*
V_{29}	.57	.50	.52	2.10	.40	.97
V_{30}	5.41*	4.57*	4.85**	3.41	.83	1.69

* significant at 5% level
** significant at 1% level

TABLE 31

Analysis of Variance F Ratios for 15 Seventh Grade Classes

Independent Variable:	Dependent Variable: Post Achievement			Dependent Variable: Post Attitude		
	Linear Regression	Curvilin Regression	Over all	Linear Regression	Curvilin Regression	Over all
V_1	20.18**	1.71	7.87**	.14	.57	.43
V_2	2.57	.74	1.35	7.64*	4.68*	5.67*
V_3	19.24**	2.85	8.31**	.32	3.72	2.58
V_4	4.72	.43	1.86	.94	2.89	2.24
V_5	3.76	1.32	2.12	.97	.08	.38
V_6	4.72	.43	1.86	.94	2.89	2.25
V_7	1.30	2.31	1.97	.02	.94	.63
V_8	1.30	2.31	1.97	.02	.94	.63
V_9	1.83	1.73	1.76	1.59	4.48	3.52
V_{10}	4.19	3.29	3.59*	2.96	.29	1.18
V_{11}	2.01	2.78	2.52	.64	.21	.35
V_{12}	1.89	1.03	1.31	.10	.78	.56
V_{13}	.33	.94	.73	.69	.61	.64
V_{14}	.45	.64	.58	.47	3.42	2.44
V_{15}	.61	.52	.55	.11	1.21	.84
V_{16}	1.31	.39	.70	.14	1.04	.74
V_{17}	11.07**	.44	3.98*	2.20	.53	1.09
V_{18}	5.92	2.15	3.41	1.91	.12	.72
V_{19}	4.72	2.50	3.24	3.73	3.71	3.72*
V_{20}	1.91	1.14	1.40	.12	1.19	.84
V_{21}	.02	1.40	.94	.80	.93	.89
V_{22}	1.37	.41	.73	1.49	.36	.74
V_{23}	1.37	.41	.73	1.49	.36	.74
V_{24}	3.09	.81	1.57	.01	.04	.03
V_{25}	.59	.30	.40	1.58	.26	.70
V_{26}	1.47	.56	.86	.58	1.39	1.12
V_{27}	5.86	.53	2.31	1.28	3.77	2.94
V_{28}	.18	.12	.14	1.51	.05	.54
V_{29}	2.56	1.00	1.52	1.26	3.62	2.83
V_{30}	4.52	3.33	3.73*	1.83	1.77	1.79

* significant at 5% level

** singificant at 1% level

TABLE 32

Analysis of Variance F Ratios for 16 Eighth Grade Classes

Independent Variable:	Dependent Variable: Post Achievement			Dependent Variable: Post Attitude		
	Linear Regression	Curvilin Regression	Over all	Linear Regression	Curvilin Regression	Over all
V_1	24.22**	.95	8.71**	1.79	.26	.75
V_2	.47	1.25	.99	18.77**	.45	6.56**
V_3	61.79**	7.17**	25.37**	.12	.95	.68
V_4	2.27	.12	.83	5.66	.23	2.04
V_5	.06	.12	.10	5.83	.21	2.09
V_6	2.27	.12	.83	5.66	.23	2.04
V_7	1.41	.64	.90	2.11	.30	.90
V_8	1.41	.64	.90	2.11	.30	.90
V_9	.22	.09	.13	7.79*	5.89*	6.52**
V_{10}	.08	3.81	2.57	7.13*	3.55	4.74*
V_{11}	.94	.29	.51	2.84	.79	1.48
V_{12}	.93	.82	.86	1.33	1.85	1.68
V_{13}	.01	.95	.63	3.18	.15	1.16
V_{14}	1.72	1.47	1.55	.12	.57	.42
V_{15}	.10	.02	.05	10.05**	1.26	4.19*
V_{16}	.16	.04	.08	.74	.99	.91
V_{17}	.62	.92	.82	1.82	3.80	3.14
V_{18}	.75	1.15	1.01	3.80	.41	1.54
V_{19}	.01	1.74	1.16	8.39	.26	2.97
V_{20}	.53	3.40	2.44	4.12	.95	2.01
V_{21}	.77	.91	.86	2.62	.48	1.20
V_{22}	.23	.49	.40	6.31	.95	2.73
V_{23}	.07	2.42	1.64	3.36	.06	1.16
V_{24}	.07	1.42	.97	.55	.29	.38
V_{25}	.08	.18	.14	5.04	2.51	3.35
V_{26}	2.70	.78	1.42	.67	.75	.72
V_{27}	.49	.24	.33	1.31	.44	.73
V_{28}	.74	1.82	1.46	2.84	.09	1.01
V_{29}	.82	.34	.50	7.48*	5.81*	6.37**
V_{30}	.08	2.35	1.60	.16	8.66**	5.83*

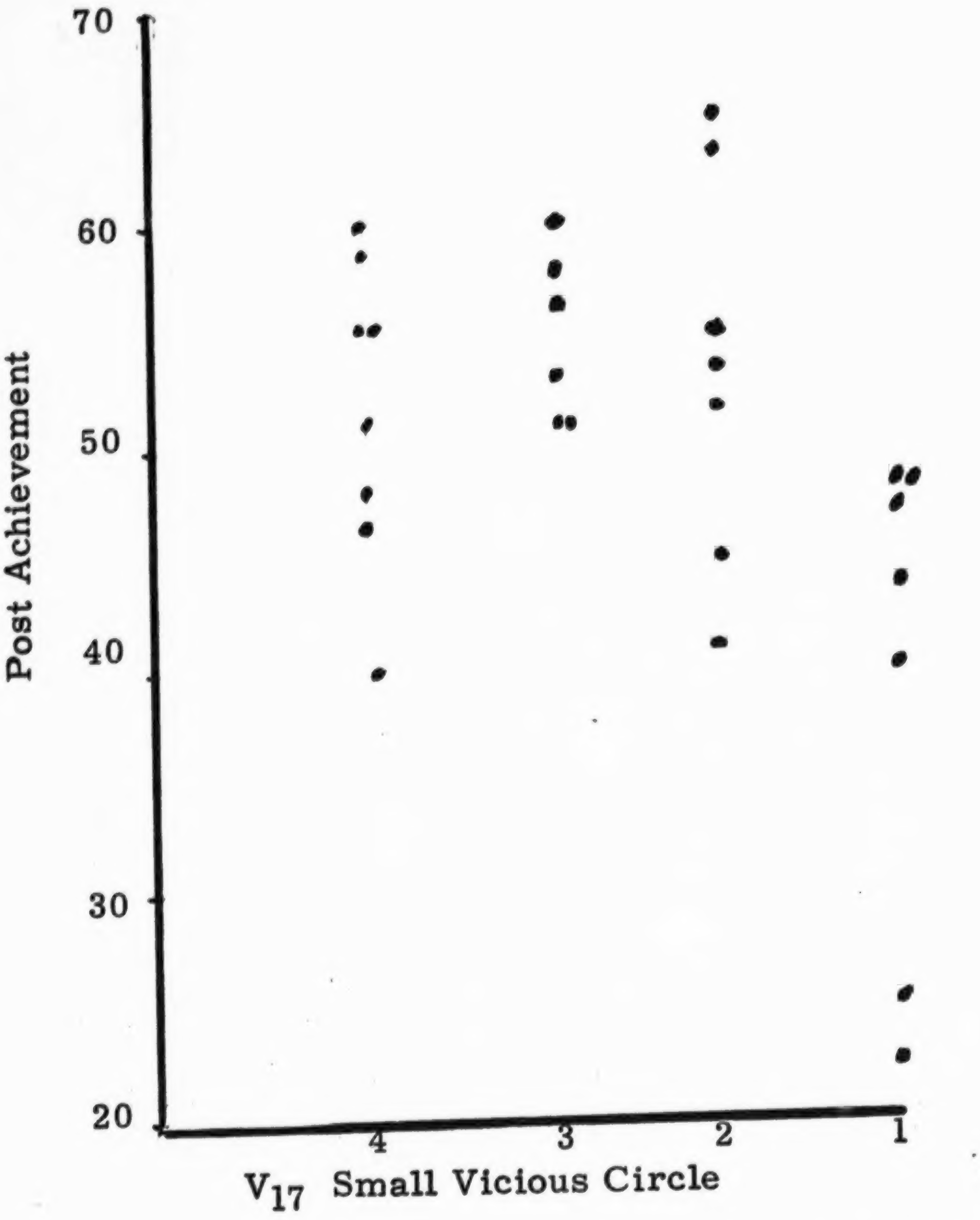
* significant at 5% level
** significant at 1% level

TABLE 33

Higher-Order Trend Analyses for Curvilinear Regressions which were both Significant and Stronger than Linear Associations

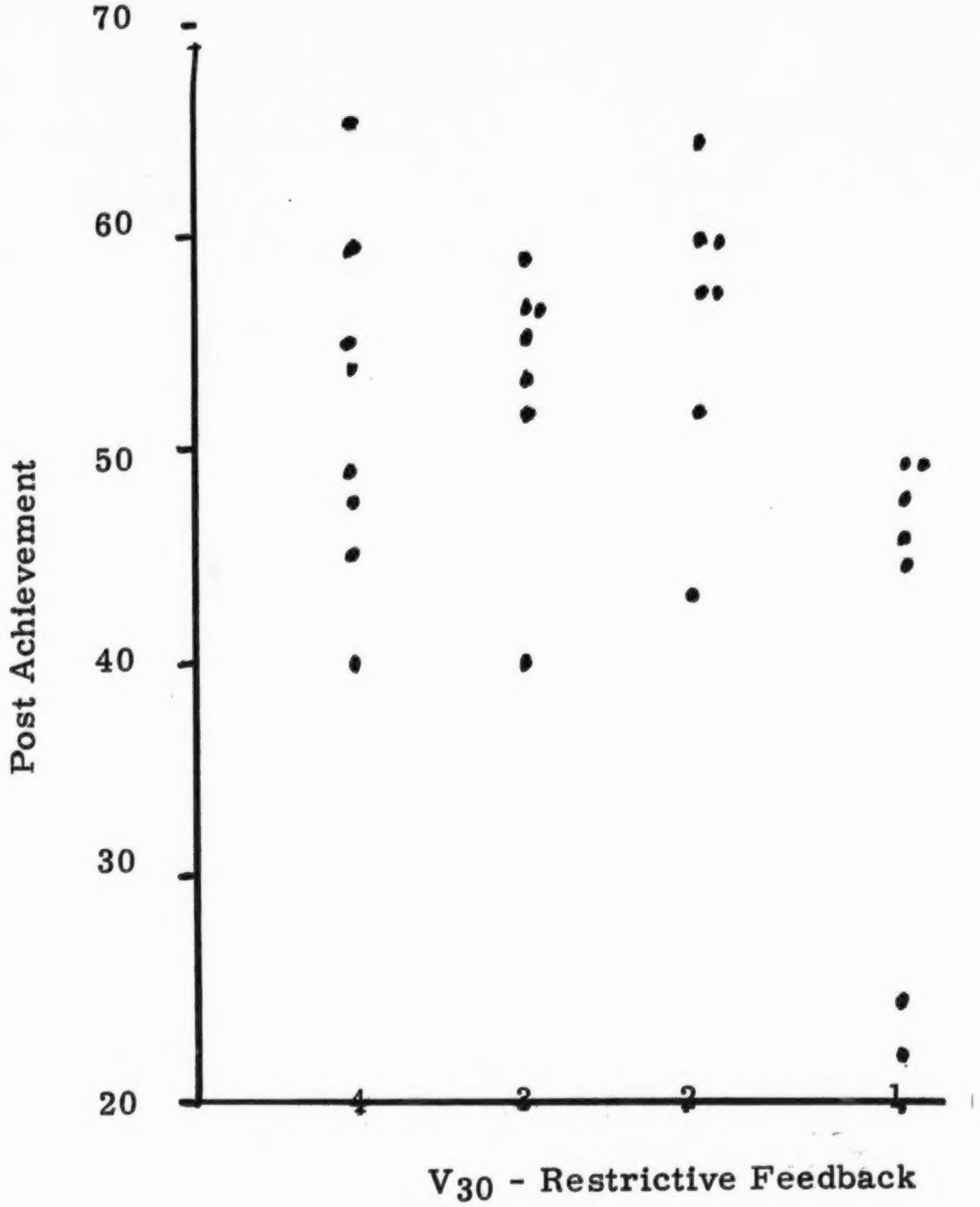
Grade	Independent Variable	Dependent Variable	F Ratio for Quadratic Regression	F Ratio for Cubic Regression
6	17	Achievement	8.8**	0.8
6	30	Achievement	6.3*	2.7
7	10	Achievement	7.1*	0.0
7	30	Achievement	7.2*	0.0
7	2	Attitude	8.1*	2.3
7	19	Attitude	0.0	7.5*
8	9	Attitude	11.8**	0.0
8	29	Attitude	11.6**	0.0

** significant at 1% level
* significant at 5% level



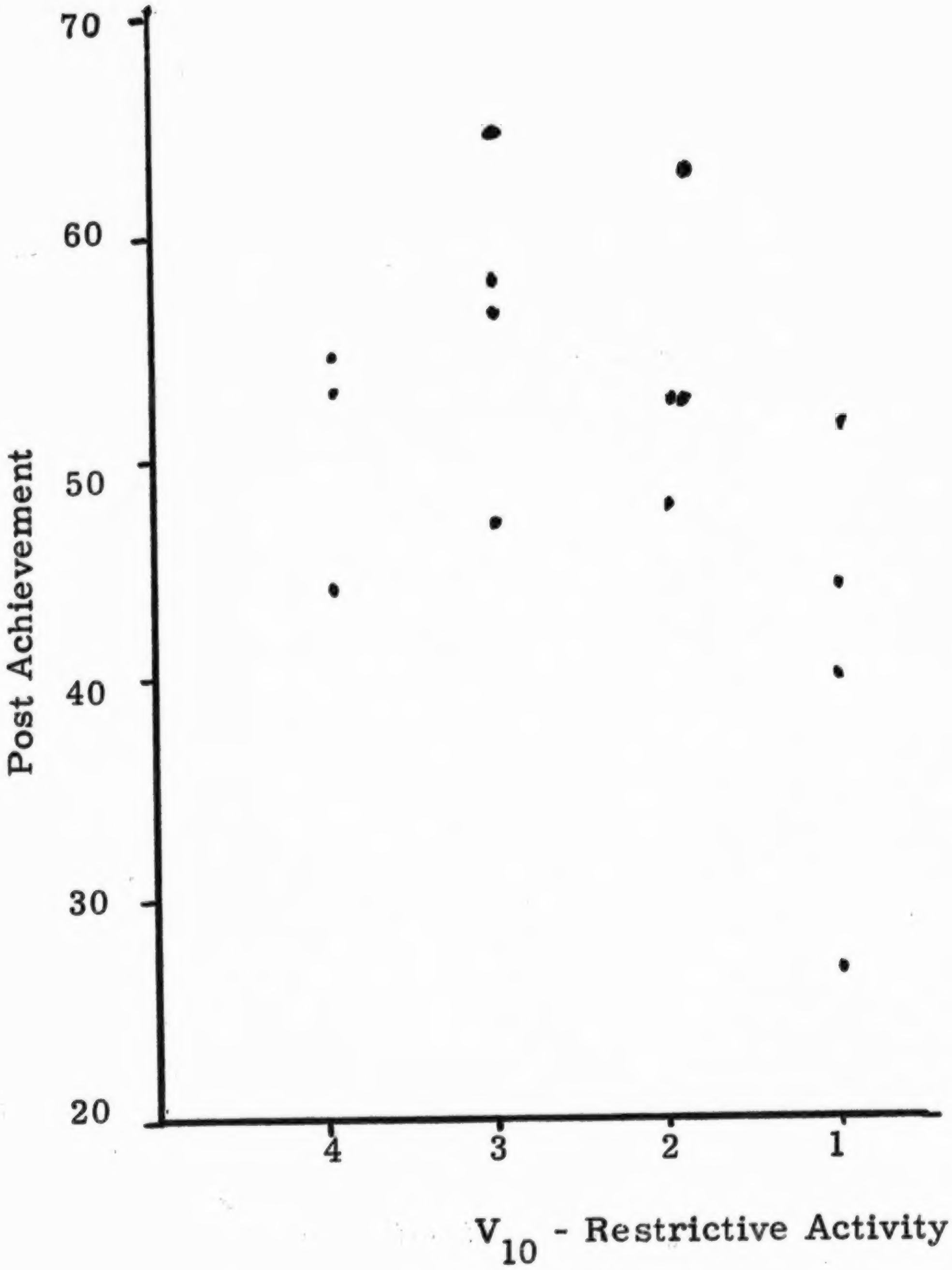
Significant Quadratic Trend for Sixth Grade $_1$

figure 6



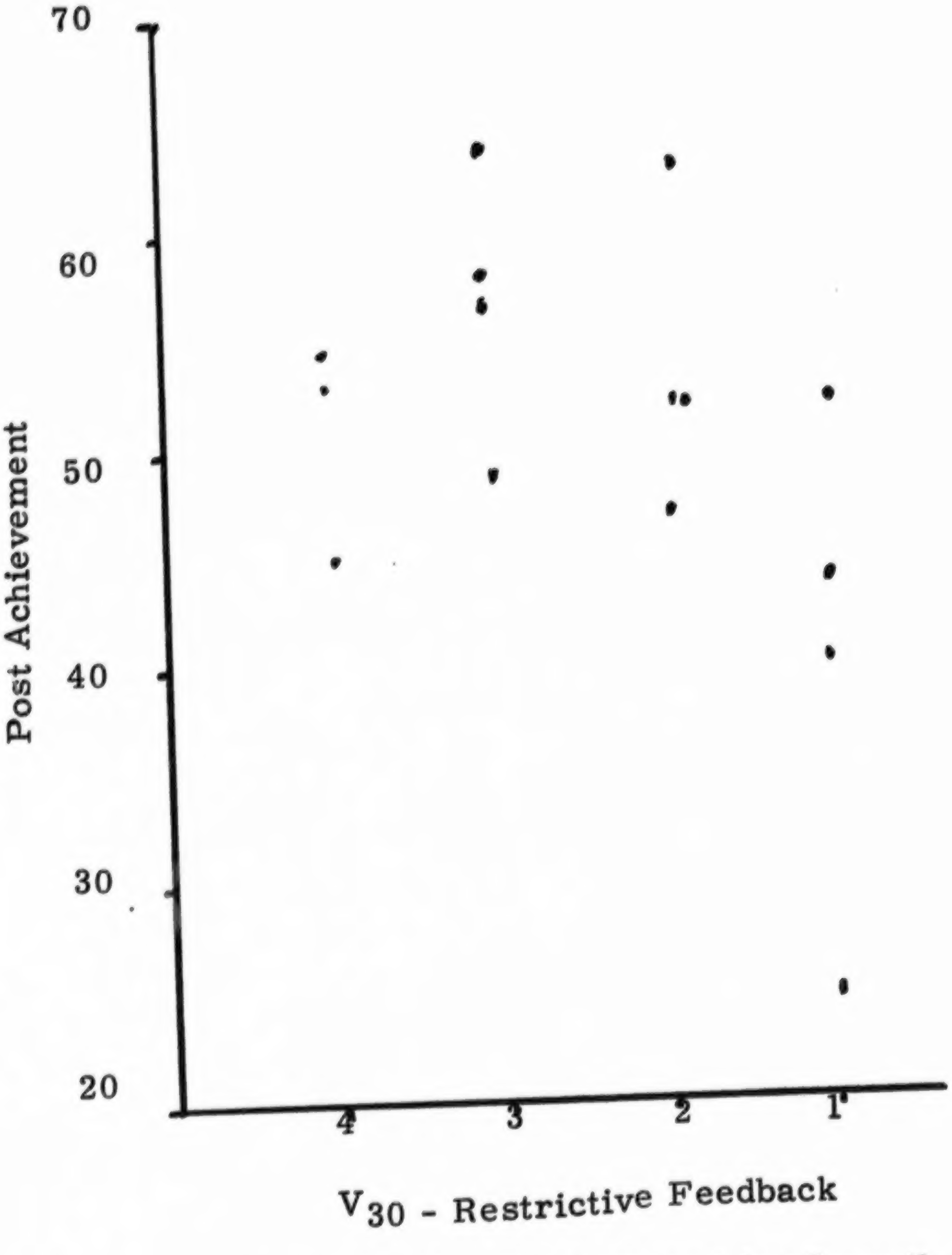
Significant Quadratic Trend for Sixth Grade 2

figure 7



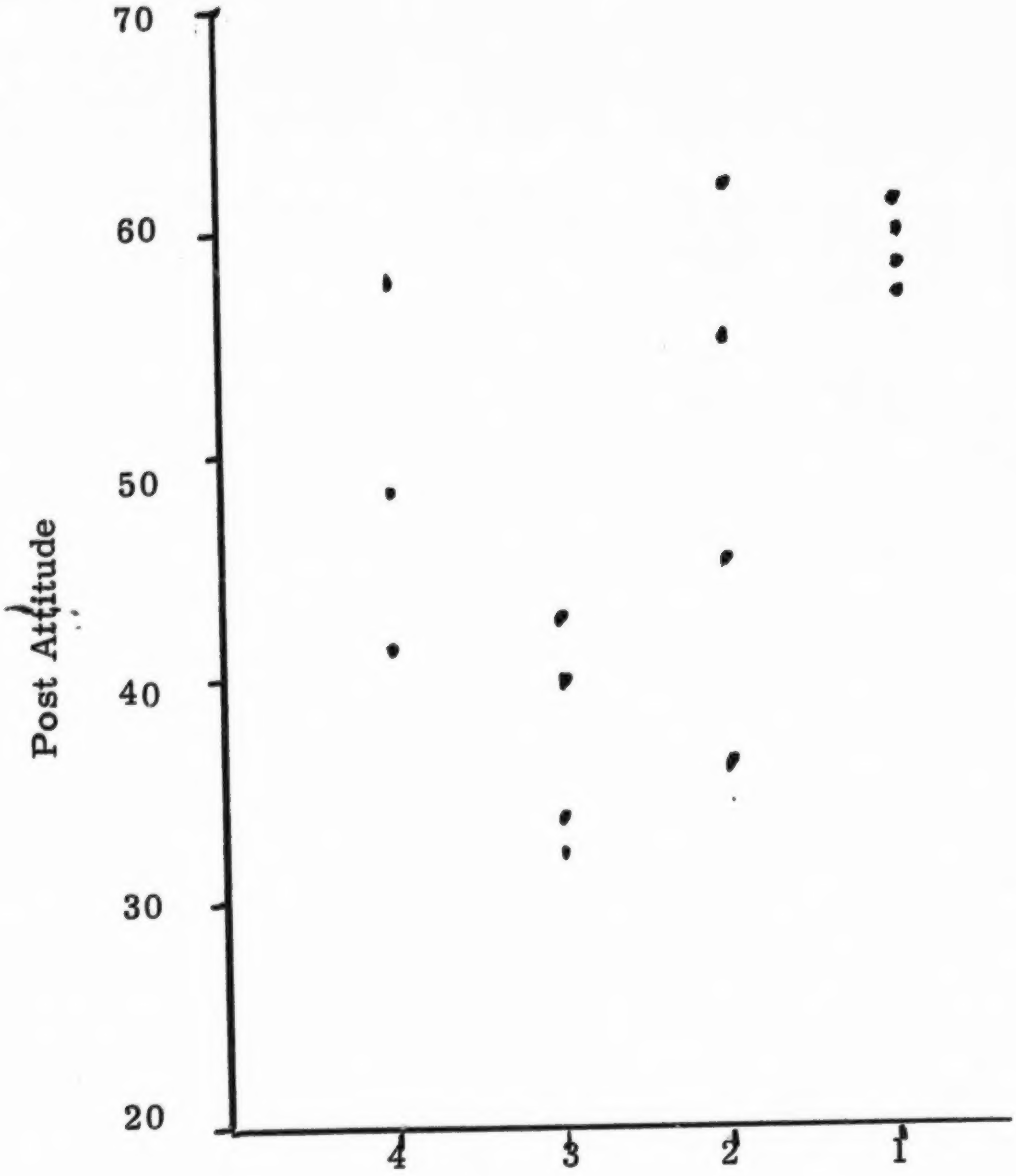
Significant Quadratic Trend for Seventh Grade $_1$

figure 8



Significant Quadratic Trend for Seventh Grade $_2$

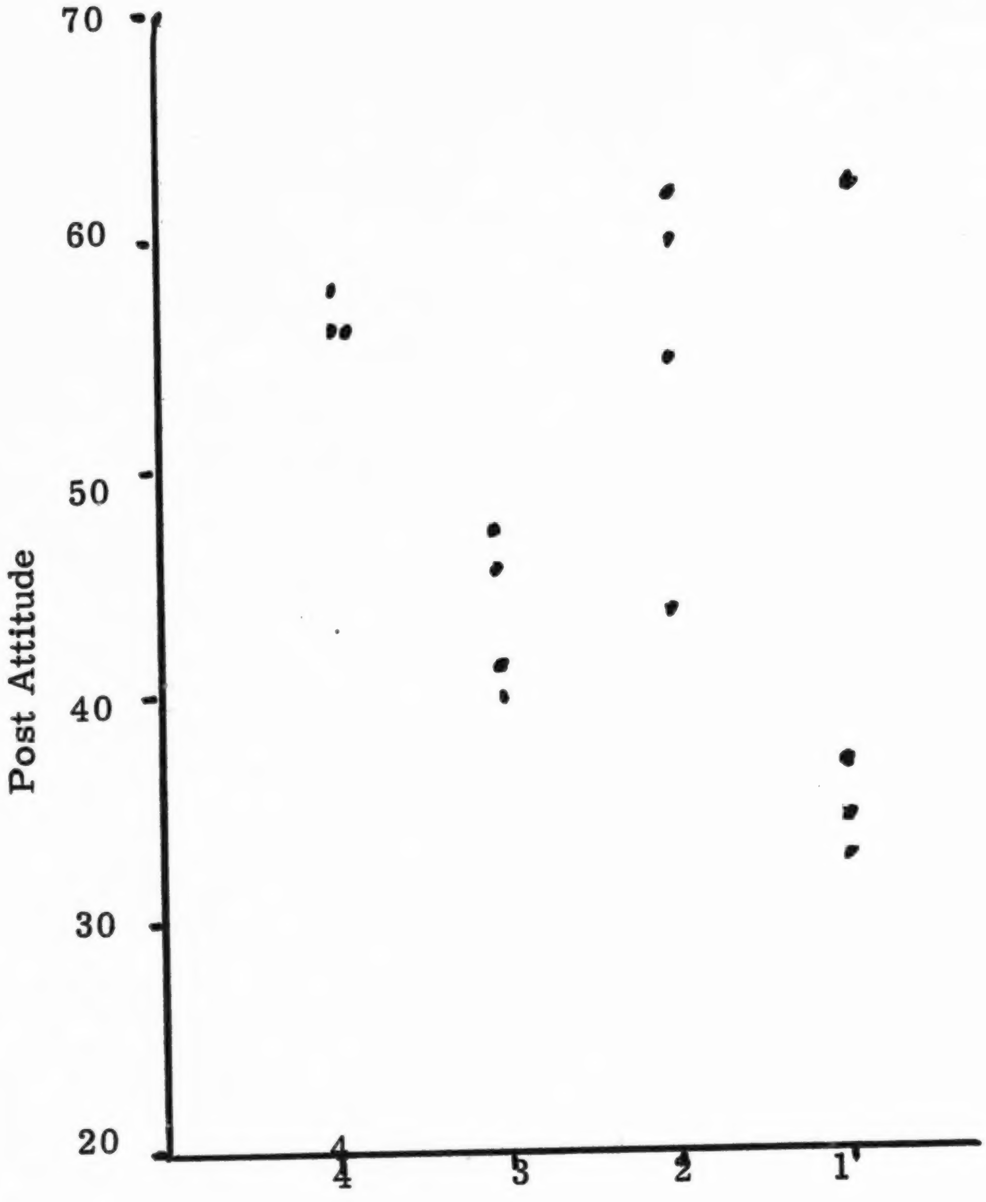
figure 9



V$_2$ - Pre-Attitude

Significant Quadratic Trend for Seventh Grade$_3$

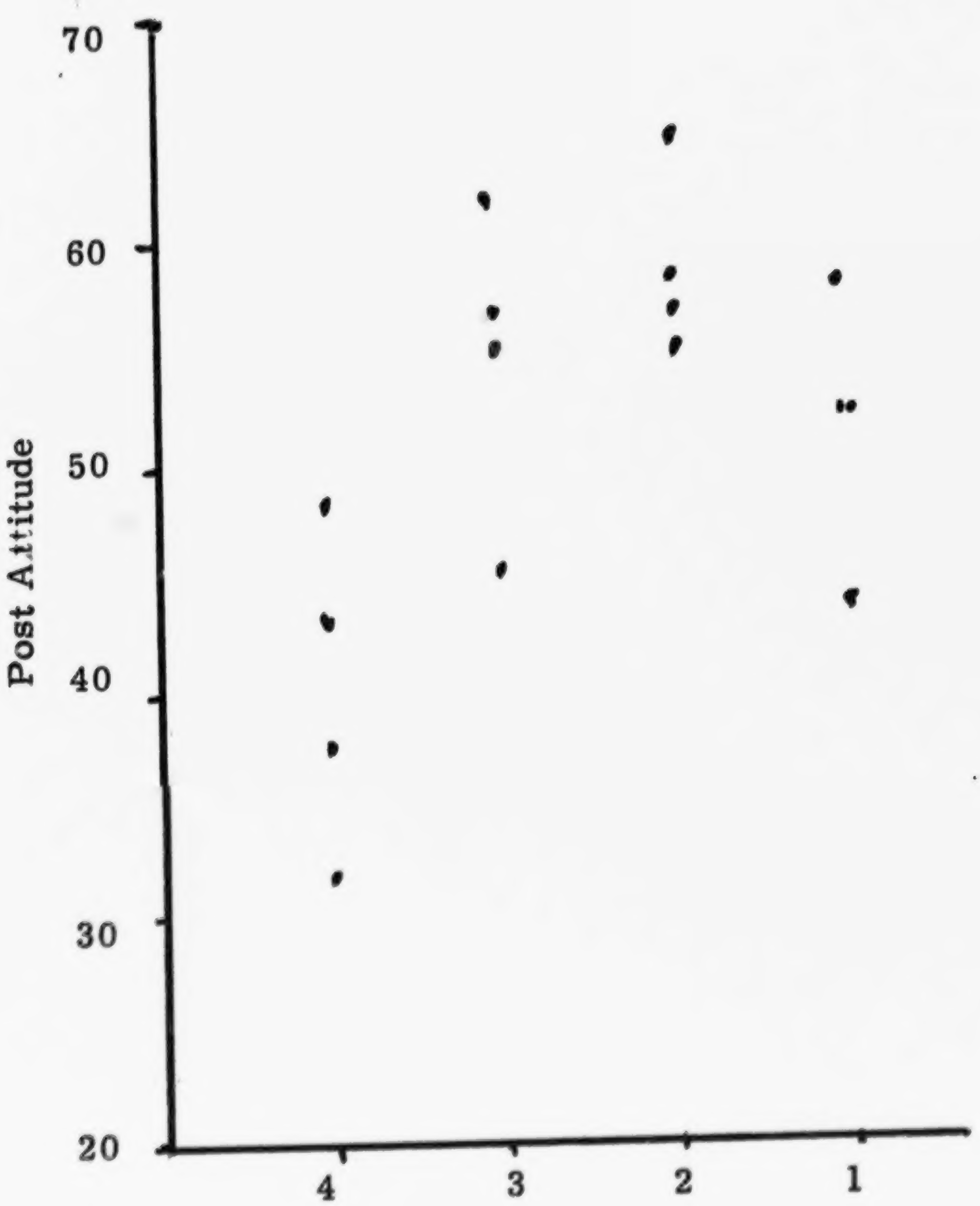
figure 10



V_{19} - Rebellion

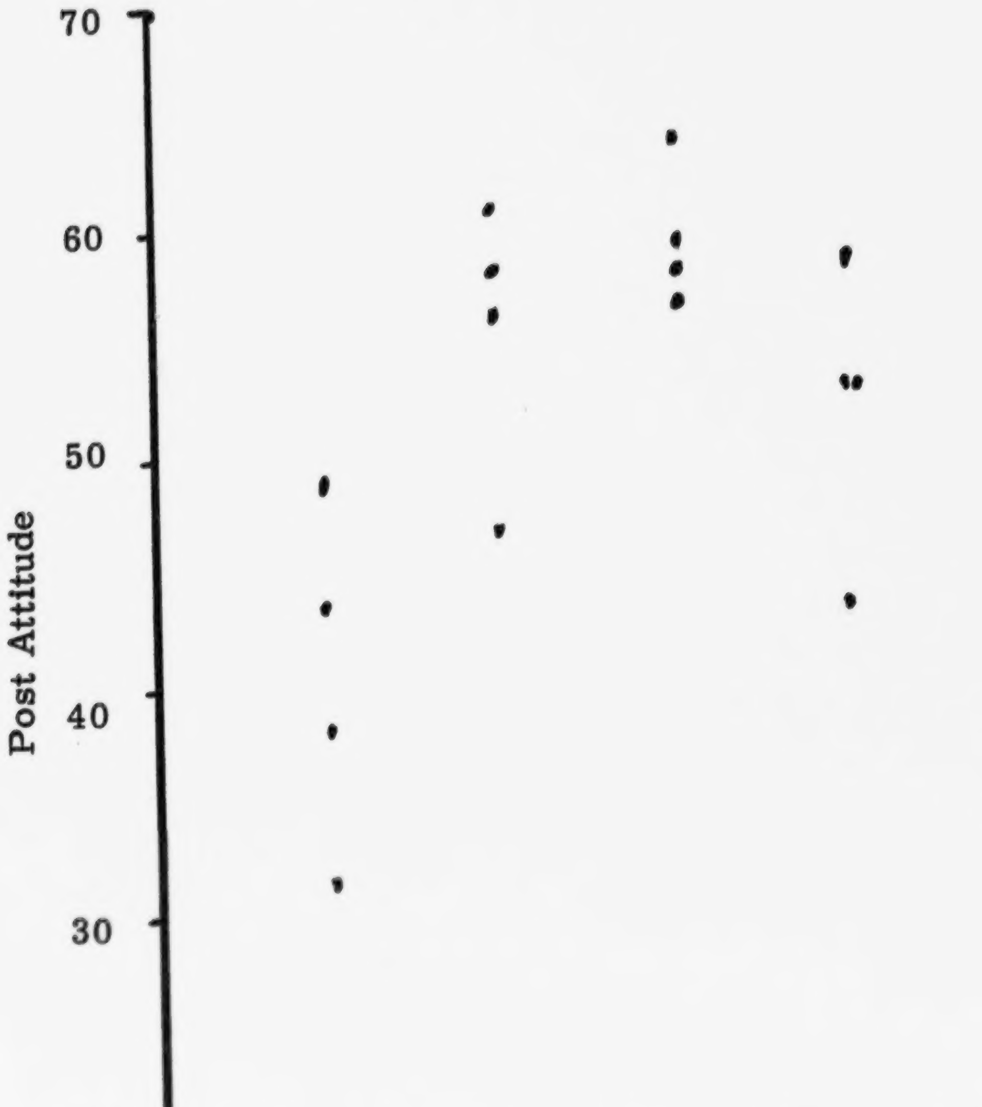
Significant Cubic Trend for Seventh Grade

figure 11



Significant Quadratic Trend for Eighth Grade$_1$

figure 12



V_{29} - Reward

Significant Quadratic Trend for Eighth Grade $_2$

figure 13

TABLE 34

Proportion of Variance in Dependent Variables Accounted for by Independent Variables in 29 Sixth Grade Classes

Independent Variable:	Dependent Variable: Post Achievement			Dependent Variable: Post Attitude		
	Linear Regression	Curvilin Regression	Over all ω^2	Linear Regression	Curvilin Regression	Over all ω^2
V_1	.69	.01	.70	.00	.00	.00
V_2	.02	.03	.05	.42	.01	.43
V_3	.51	.04	.55	.00	.00	.00
V_4	.18	.06	.24	.13	.00	.13
V_5	.00	.00	.00	.00	.00	.00
V_6	.18	.06	.24	.13	.00	.13
V_7	.00	.00	.00	.05	.03	.08
V_8	.00	.00	.00	.05	.03	.08
V_9	.07	.03	.10	.15	.00	.15
V_{10}	.02	.00	.02	.05	.00	.05
V_{11}	.00	.00	.00	.15	.00	.15
V_{12}	.00	.07	.07	.00	.00	.00
V_{13}	.00	.00	.00	.04	.00	.04
V_{14}	.00	.06	.06	.00	.00	.00
V_{15}	.03	.03	.06	.00	.00	.00
V_{16}	.00	.00	.00	.00	.11	.11
V_{17}	.15	.18	.33	.05	.00	.05
V_{18}	.00	.01	.01	.01	.00	.01
V_{19}	.10	.00	.10	.13	.00	.13
V_{20}	.00	.00	.00	.05	.00	.05
V_{21}	.00	.00	.00	.00	.00	.00
V_{22}	.00	.00	.00	.00	.00	.00
V_{23}	.00	.00	.00	.01	.13	.14
V_{24}	.00	.06	.06	.00	.00	.00
V_{25}	.00	.00	.00	.00	.00	.00
V_{26}	.20	.13	.33	.15	.05	.20
V_{27}	.15	.13	.28	.13	.00	.13
V_{28}	.01	.07	.08	.21	.02	.23
V_{29}	.00	.00	.00	.00	.00	.00
V_{30}	.11	.18	.29	.07	.00	.07

TABLE 35

Proportion of Variance in Dependent Variables Accounted for by Independant Variables in 15 Seventh Grade Classes.

Independent Variable:	Dependent Variable: Post Achievement			Dependent Variable: Post Attitude		
	Linear Regression	Curvilin Regression	Over all ω^2	Linear Regression	Curvilin Regression	Over all ω^2
V_1	.54	.04	.58	.00	.00	.00
V_2	.07	.00	.07	.23	.25	.48
V_3	.49	.10	.59	.00	.24	.24
V_4	.15	.00	.15	.00	.20	.20
V_5	.15	.04	.19	.00	.00	.00
V_6	.15	.00	.15	.00	.20	.20
V_7	.02	.15	.17	.00	.00	.00
V_8	.02	.15	.17	.00	.00	.00
V_9	.05	.08	.13	.03	.31	.34
V_{10}	.14	.20	.34	.04	.00	.04
V_{11}	.05	.18	.23	.00	.00	.00
V_{12}	.06	.00	.06	.00	.00	.00
V_{13}	.00	.00	.00	.00	.00	.00
V_{14}	.00	.00	.00	.00	.22	.22
V_{15}	.00	.00	.00	.00	.00	.00
V_{16}	.00	.00	.00	.00	.00	.00
V_{17}	.37	.00	.37	.02	.00	.02
V_{18}	.22	.10	.32	.00	.00	.00
V_{19}	.17	.14	.31	.12	.23	.35
V_{20}	.06	.02	.08	.00	.00	.00
V_{21}	.00	.00	.00	.00	.00	.00
V_{22}	.00	.00	.00	.00	.00	.00
V_{23}	.00	.00	.00	.00	.00	.00
V_{24}	.10	.00	.10	.00	.00	.00
V_{25}	.00	.00	.00	.00	.00	.00
V_{26}	.00	.00	.00	.00	.02	.02
V_{27}	.21	.00	.21	.01	.27	.28
V_{28}	.00	.00	.00	.00	.00	.00
V_{29}	.09	.00	.09	.01	.26	.27
V_{30}	.15	.20	.35	.05	.09	.14

TABLE 36

Proportion of Variance in Dependent Variables Accounted for by Independent Variables in 16 Eighth Grade Classes

Independent Variable:	Dependent Variable: Post Achievement			Dependent Variable: Post Attitude		
	Linear Regression	Curvilin Regression	Over all ω^2	Linear Regression	Curvilin Regression	Over all ω^2
V_1	.59	.00	.59	.00	.00	.00
V_2	.00	.00	.00	.51	.00	.51
V_3	.68	.14	.82	.00	.00	.00
V_4	.00	.00	.00	.16	.00	.16
V_5	.00	.00	.00	.17	.00	.17
V_6	.00	.00	.00	.16	.00	.16
V_7	.00	.00	.00	.00	.00	.00
V_8	.00	.00	.00	.00	.00	.00
V_9	.00	.00	.00	.21	.30	.51
V_{10}	.00	.23	.23	.23	.19	.42
V_{11}	.00	.00	.00	.08	.00	.08
V_{12}	.00	.00	.00	.02	.09	.11
V_{13}	.00	.00	.00	.03	.00	.03
V_{14}	.04	.05	.09	.00	.00	.00
V_{15}	.00	.00	.00	.35	.02	.37
V_{16}	.00	.00	.00	.00	.00	.00
V_{17}	.00	.00	.00	.04	.25	.29
V_{18}	.00	.00	.00	.09	.00	.09
V_{19}	.00	.03	.03	.27	.00	.27
V_{20}	.00	.21	.21	.16	.00	.16
V_{21}	.00	.00	.00	.04	.00	.04
V_{22}	.00	.00	.00	.25	.00	.25
V_{23}	.00	.11	.11	.03	.00	.03
V_{24}	.00	.00	.00	.00	.00	.00
V_{25}	.00	.00	.00	.18	.13	.31
V_{26}	.07	.00	.07	.00	.00	.00
V_{27}	.00	.00	.00	.00	.00	.00
V_{28}	.00	.08	.08	.00	.00	.00
V_{29}	.00	.00	.00	.20	.30	.50
V_{30}	.00	.10	.10	.00	.48	.48

APPENDIX E

Regression Analysis

by Grade Level

TABLE 37

Step by Step Results of Regression Analyses Using Standardized T-Scores on All 30 Independent Variables to Predict Dependent Variable Scores

Grade	Step	Predictor Variables	Dependent Variable	R	R^2
6	1	1	Achievement	.99	.97
	2	1,2		.99	.98
	3	1,2,23		.99	.98
	4	1,2,23,28		.99	.98
	5	1,2,4,23,28		.99	.98
	6	1,2,4,6,23,28		.99	.98
6	1	2	Attitude	.87	.75
	2	2,15		.88	.77
	3	2,9,15		.89	.79
	4	2,4,9,15		.90	.81
	5	2,4,9,15,28		.91	.84
	6	2,4,5,9,15,28		.92	.85
7	1	3	Achievement	.86	.75
	2	1,3		.92	.84
	3	1,2,3		.95	.90
	4	1,2,3,17		.96	.92
	5	1,2,3,4,17		.96	.93
	6	1,2,3,4,14,17		.97	.95
7	1	2	Attitude	.69	.47
	2	2,17		.78	.60

TABLE 37 --continued

Grade	Step	Predictor Variables	Dependent Variable	R	R^2
	3	2,17,28		.82	.68
	4	2,5,17,28		.86	.74
	5	2,5,7,17,28		.87	.76
	6	2,5,7,17,19,28		.89	.79
	1	1	Achievement	.92	.85
	2	1,3		.97	.95
	3	1,3,20		.98	.95
	4	1,3,17,20		.99	.97
	5	1,3,15,17,20		.99	.98
	6	1,3,15,17,19,20		.99	.99
8	1	2	Attitude	.73	.54
	2	2,19		.87	.75
	3	2,19,28		.90	.80
	4,	2,18,19,28		.92	.84
	5	2,18,19,24,28		.93	.86
	6	1,2,18,19,24,28		.93	.87

TABLE 38

Step By Step Results of Regression Analyses Using Quartile Levels on All 30 Independent Variables to Predict Dependent Variable Scores

Grade	Step	Predictor Variables	Dependent Variable	R	R^2
6	1	1	Achievement	.84	.71
	2	1,28		.87	.76
	3	1,3,28		.88	.78
	4	1,3,16,28		.79	.50
	5	1,3,16,21,28		.90	.81
	6	1,3,12,16,21,28		.92	.85
6	1	2	Attitude	.67	.45
	2	2,19		.74	.55
	3	2,19,28		.77	.59
	4	2,13,19,28		.79	.62
	5	2,12,13,19,28		.80	.65
	6	2,12,13,16,19,28		.83	.68
7	1	1	Achievement	.76	.58
	2	1,5		.86	.74
	3	1,3,5		.88	.77
	4	1,3,5,17		.90	.80
	5	1,3,5,17,26		.94	.88
	6	1,3,5,7,17,26		.97	.93
7	1	2	Attitude	.52	.27
	2	2,17		.73	.53

TABLE 38 (continued)

Grade	Step	Predictor Variables	Dependent Variable	R	R^2
	3	2,17,28		.79	.63
	4	2,17,24,28		.87	.76
	5	2,3,17,24,28		.90	.81
	6	2,3,17,24,25,28		.92	.84
8	1	3	Achievement	.84	.70
	2	1,3		.93	.86
	3	1,3,28		.95	91
	4	1,3,17,28		.96	.92
	5	1,3,16,17,28		.97	.94
	6	1,3,12,16,17,28		.99	.97
8	1	2	Attitude	.77	.59
	2	2,11		.88	.77
	3	1,2,11		.92	.84
	4	1,2,11,28		.93	.86
	5	1,2,11,12,28		.94	.88
	6	1,2,11,12,23,28		.95	.90
All	1	1	Achievement	.80	.64
	2	1,3		.85	.73
	3	1,3,30		.87	.75
	4	1,3,28,30		.87	.76
	5	1,3,16,28,30		.88	.77
	6	1,3,13,16,28,30		.89	.79

TABLE 38 (continued)

Grade	Step	Predictor Variables	Dependent Variable	R	R^2
	7	1,3,12,13,16,28,30		.90	.80
	8	1,3,7,12,13,16,28,30		.90	.81
All	1	2	Attitude	.72	.52
	2	2,19		.76	.58
	3	2,4,19		.77	.59
	4	2,4,10,19		.80	.63
	5	2,4,10,18,19		.82	.67
	6	2,4,10,18,19,26		.83	.68
	7	2,4,10,15,18,19,26		.83	.70
	8	2,4,10,15,18,19,26,29		.84	.70

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